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How a Molding Machine Saved Money on a Job

The Economies Effected by Mounting a Pattern on a Squeezer—The Molds Were Stacked for Pouring

By C B Morehouse

WITH A view to increasing the output and reducing the cost, I studied my line of work and the different types of molding machines for a considerable period. The more deeply I investigated the more thoroughly I became convinced that I could accomplish the results sought by machine-molding methods and the following will demonstrate how well I succeeded. This job is only one of the many which we are now making on molding machines, thereby increasing the output and reducing the cost as compared with our former hand-molding methods.

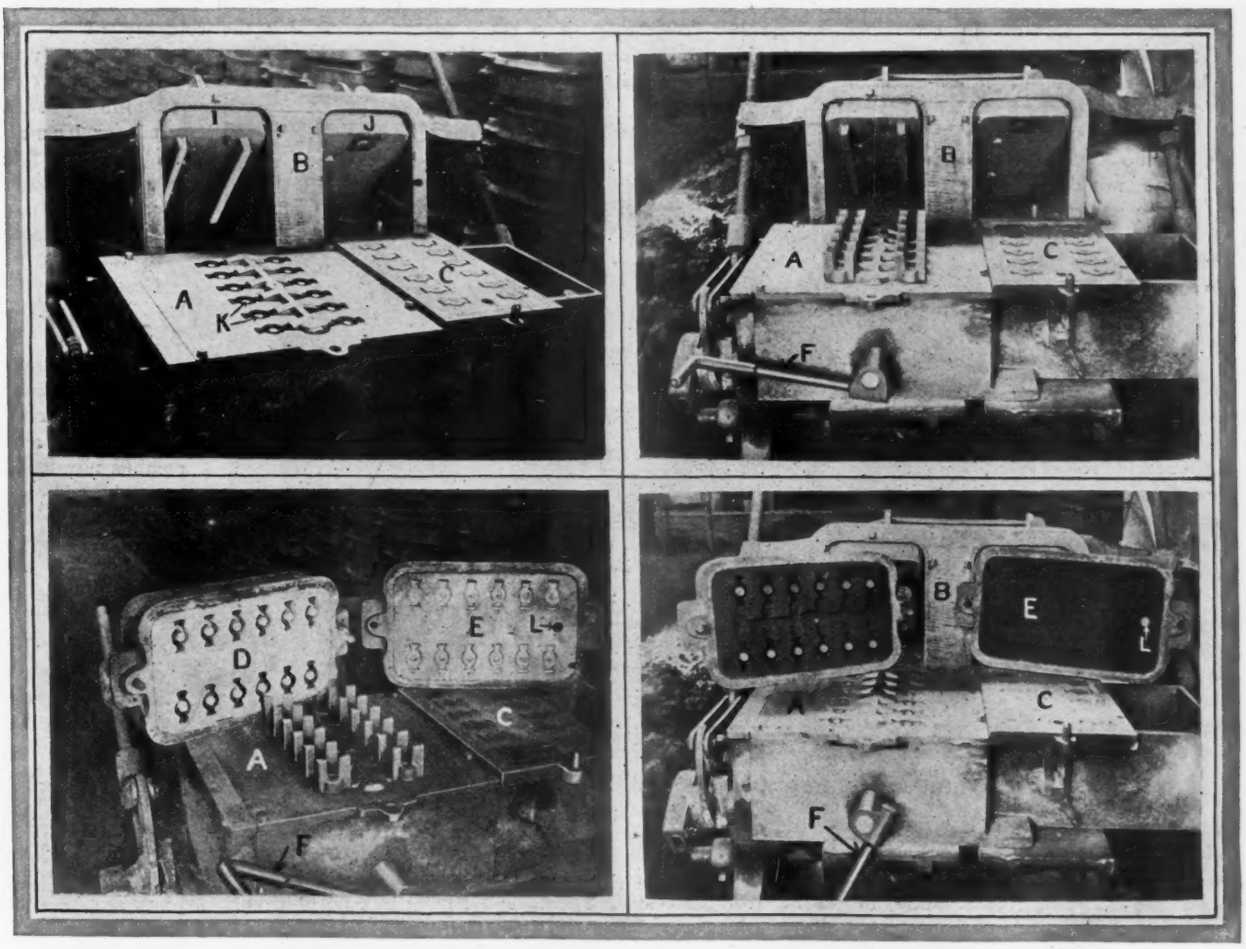


FIG. 1—STRIPPING PLATE, PRESSER FRAME AND PRESSER BOARDS
FIG. 3—DRAG AND COPE HALVES OF THE MOLD

FIG. 2—PATTERNS RAISED THROUGH STRIPPING PLATE AND IN MOLDING POSITION
FIG. 4—ANOTHER VIEW OF THE MACHINE, SHOWING THE PATTERNS LOWERED THROUGH THE STRIPPING PLATE

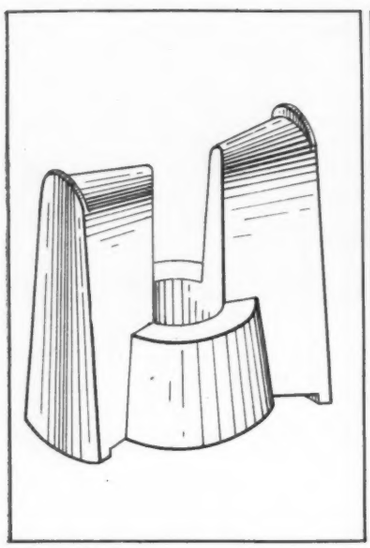


FIG. 5—BEAM SPACER CASTING

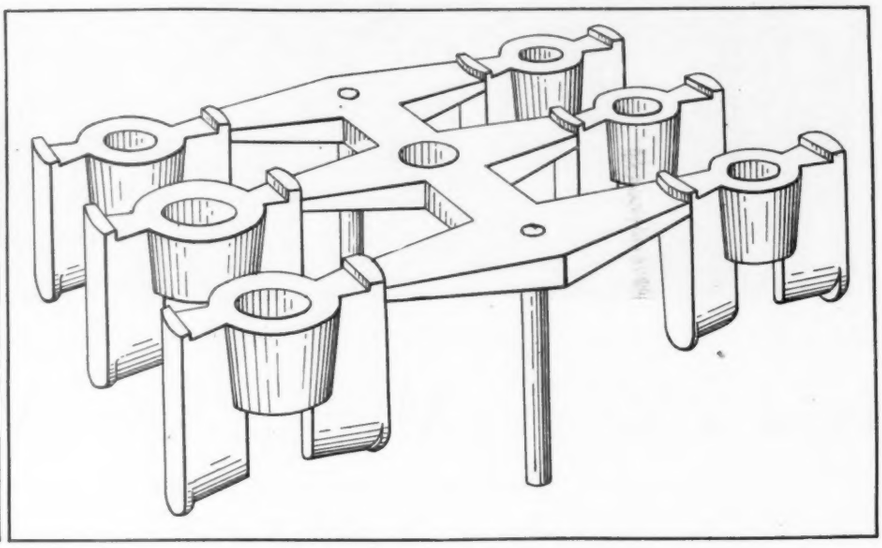


FIG. 6—GATED PATTERNS FOR BENCH MOLDING

The casting which will be discussed is a beam spacer for a cultivator, as shown in Fig. 5. The gate of patterns as employed for bench molding is illustrated in Fig. 6. It will be noted that there are only six patterns on this gate, constituting six castings in the mold and the percentage of loss when made by hand was high, as it is essential that these castings be of uniform size. As no two molders would rap the pattern the same, the discount was excessive as a result of size variations. Since this job has been mounted on a molding machine, the losses have been greatly reduced and the castings are absolutely uniform in size.

In Fig. 1, the stripping plate frame is shown at *A*, the presser frame at *B*, the stripping plate at *C* and the presser boards at *I* and *J*; *F*, Fig. 2, is the lever by which the pattern is drawn. In Figs. 1 and 4, the pattern is dropped through the stripping plate, while in Figs. 2 and 3 it is raised in molding position. The stripping post, *K*, Fig. 1, insures clean, smooth openings in the castings, as the cores are supported by these stools while the pattern is being drawn and ragged edges are prevented. In Fig. 3 the drag half of the mold is shown at *D*, while *E* is the cope. The gate is illustrated at *L*.

Fig. 7 shows the machine with a flask and presser frame in position ready for the molding operation. The method of stacking the molds also is clearly shown in this illustration. By arranging the mlds in this way floor space is economized, as the molds are stacked four-high and the pouring operation is greatly facilitated. When the molds were made in snap flasks, each mold contained only six castings, whereas 12 are now poured in the molds made on the machine.

On the bench one man made 80 molds or 480 castings in a day, whereas on a machine the same man makes 200 molds or 2,400 castings, netting him an increase of 50 per cent in wages and effecting a saving for the company of 70 per cent. In addition, better and more uniform castings are obtained. The cost of the pattern used for bench molding was $18, while the cost of the machine pattern was $38.

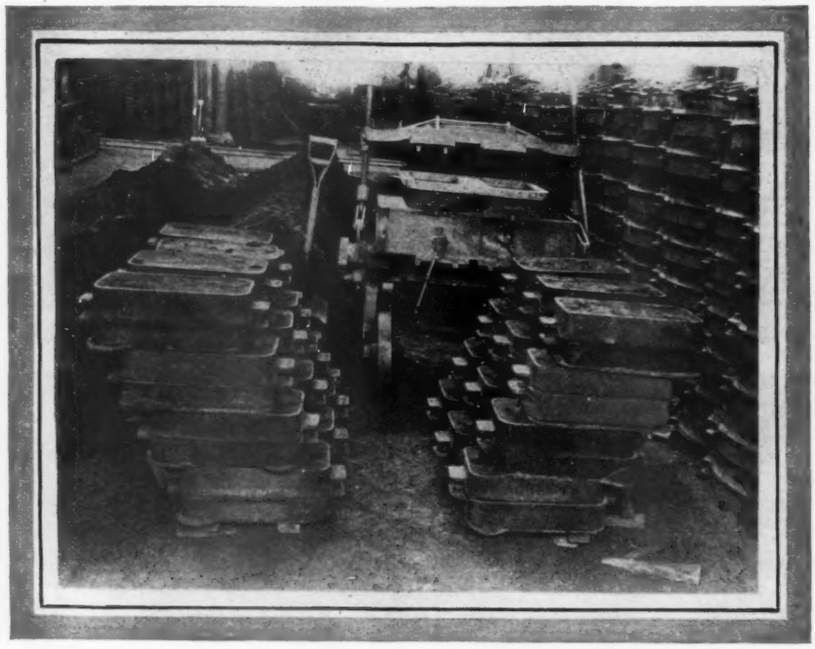


FIG. 7—HOW THE MOLDS ARE STACKED. THE MOLDING MACHINE IS SHOWN IN THE BACKGROUND

Copper may be colored brown by the use of the following solution: Water, 1 gallon; sodium chlorate, 12 ounces; ammonium nitrate, 12 ounces, and copper nitrate, 1¼ ounces. The solution is used hot and the article is permitted to remain therein for about 10 minutes. The copper nitrate should be neutral. Passive copper, or that which has been boiled in a sodium hydroxide solution, will not take the color. Tin, zinc and lead are dissolved by the solution, and aluminum becomes coated with a film of oxide. If these metals are present in the article to be colored along with copper, it will not take the brown color.

Influence of Silicon on Corrosion of Cast Iron*

The Report of an Interesting Series of Tests to Ascertain the Results of Varying Amounts of This Element in Iron

By J Newton Friend and C W Marshall

OWING to its relatively low melting point, the ease with which objects may be cast from it, and their extreme hardness when completed, cast iron is now being used for commercial purposes in ever-increasing quantities. It is eminently desirable, therefore, in view of the serious nature of the corroding influences to which articles are exposed, to determine what the influence of varying constituents may be on the corrodibility of cast iron, and to learn what particular compositions offer the maximum resistance to corrosion.

Hitherto but little work has been done in this connection, which affords a wide field for research, inasmuch as the chemical composition of cast iron and the physical conditions at the time of experiment, admit of enormous variation. The problems are, in consequence, proportionately complicated, and a vast amount of work remains to be done before generalizations of any real value can be made. In the present paper the authors give the results of a study of the influence of silicon upon the corrodibility of cast iron.

For many years chemists have recognized that the presence of alloyed silicon tends to retard the corrosion of iron. Thus Mallet, more than 70 years ago was aware that cast iron rich in silicon is less readily attacked by acids, and Jouve has recently proved that alloys of silicon and iron containing 20 per cent of the former element are remarkably resistant to acid attack. But alloys such as these are not cast iron, and their utility is greatly restricted by the difficulty of working them on account of the peculiar properties imparted to them by the silicon.

The authors have, therefore, confined their attention to the influence on corrodibility exerted by a silicon content varying from 1.24 to 2.28 per cent. They would gladly have extended this series had it been possible, but the advantage of studying this particular range is twofold:

1.—It covers many of the various silicon contents usually met with in commercial cast irons, and the results are not, therefore, of purely scientific interest.

2.—The silicon is never so great as to interfere with the nature of the carbon content.

The latter is a most important point, and one to which we hope it may be possible to give further attention at a later date. As is well known, the presence of silicon tends to throw out the carbon as graphite, thereby rendering the metal porous and more liable to corrosion. Consequently, unless particular care be taken to keep the carbon in the same condition, both physically and chemically, the influence of the silicon *per se* upon the corrodibility of the metal must be affected by the proportion of graphitic carbon, and the results rendered misleading. The irons were cut into blocks measuring 4.8 x 1.1 x 1.5 cubic centimeters, and after rubbing with emery paper were tested in this form. Analyses of the various cast iron blocks tested are given in Table I.

It will be observed, in Table I, that with the exception of the silicon the other elements are present in the cast iron in remarkably uniform proportions. The corrosion of the samples containing the lowest quantity of silicon, No. 1, is, in all the accompanying series, taken as 100, the corrodibilities of the other samples being expressed accordingly.

The samples of iron were laid on sheets of paraffine wax in glass beakers containing 500 cubic centimeters of tap water. After 17 weeks the irons were removed, carefully scraped free from rust, rinsed in alcohol, and dried in a steam oven. They were then weighed, the loss in weight being taken as a measure of the corrosion. The results are given in Table II.

Table I.

Analyses of Cast Iron Tested

Cast iron No.	Percentage Composition					
	Silicon.	Graphite.	Combined carbon.	Manganese.	Sulphur.	Phosphorus.
1	1.24	2.70	0.65	0.63	0.096	0.99
2	1.29	2.65	0.68	0.75	0.093	1.05
3	1.45	2.55	0.65	0.89	0.082	1.04
4	1.55	2.70	0.67	0.86	0.079	1.02
5	1.72	2.75	0.61	0.75	0.085	1.06
6	2.04	2.60	0.51	0.86	0.115	1.09
7	2.28	2.75	0.55	0.69	0.076	1.04

Table II.

Corrosion of Cast Iron in Tap Water, 17 Weeks' Exposure

Cast iron No.	Silicon per cent.	Original weight grams.	Loss in weight, grams.	Corrosion factor.
1	1.24	57.0494	0.4040	100
2	1.29	57.3176	0.3276	81
3	1.45	57.6996	0.4098	101
4	1.55	54.5768	0.4028	100
5	1.72	56.9500	0.3890	99
6	2.04	59.4522	0.3846	95
7	2.28	57.6416	0.3554	88

Table III.

Corrosion of Cast Irons in 3 Per Cent Sodium Chloride Solution, 13 Weeks' Exposure

Cast iron No.	Silicon per cent.	Original weight grams.	Loss in weight, grams.	Corrosion factor.
1	1.24	57.0036	0.3134	100
2	1.29	57.3356	0.2882	92
3	1.45	57.6354	0.2974	95
4	1.55	54.9200	0.3112	99
5	1.72	57.2766	0.3182	101
6	2.04	58.5736	0.3172	101
7	2.28	58.5102	0.2758	88

*Presented at the annual meeting of the Iron and Steel Institute.

The salt water experiments were carried out in a precisely similar manner to the preceding ones, save that the liquid corrosive medium was 3 per cent salt solution. The results are given in Table III.

The results of the sulphuric acid tests were obtained in an exactly similar manner to those with tap water, the corroding liquid in this case being 0.05 per cent sulphuric acid, that is, 0.5 gram of acid in 1,000 grams of solution with water. The acid was renewed every 14 days. The results of these tests are contained in Table IV.

Table IV.

Corrosion of Cast Iron in 0.05 Per Cent Sulphuric Acid, 13 Weeks' Exposure

Cast iron No.	Silicon per cent.	Original weight grams.	Loss in weight, grams.	Corrosion factor.
1	1.24	56.6814	0.5962	100
2	1.29	56.3498	0.6258	105
3	1.45	57.8794	0.5938	100
4	1.55	55.9416	0.5826	98
5	1.72	56.9324	0.6192	104
6	2.04	58.4756	0.6182	104
7	2.28	56.8700	0.6000	101

The tests with 0.5 per cent sulphuric acid were similar to the preceding, save that stronger acid was employed, which was renewed every 14 days. These results are contained in Table V.

For the sake of facilitating the discussion of these results Table VI has been drawn up, in which the corrosion factors of the cast irons as obtained in the present research are grouped together.

A study of the above table reveals the following interesting facts:

1.—The corrosion factors for the irons in acid and neutral media are almost identical. This is remarkable in view of the divergence usually observed between the two in the case of steels.

2.—All the irons corrode at a uniform rate, although No. 7 shows a slight tendency to corrode less rapidly in neutral solution. Possibly this indicates that if the percentage of silicon were raised still higher, without affecting the proportions of graphitic and combined carbon, a gradual increase in resistance to corrosion would be observed. We may safely conclude, however, that a variation in the percentage of silicon between the limits of 1.2 and 2.3 per cent has no appreciable influence *per se* upon the corrodibility of the cast iron. If the relative proportions of graphitic and combined carbon are simultaneously varied with the silicon, a considerable difference in the corrodibility may be expected.

Table V.

Corrosion of Cast Iron in 0.5 Per Cent Sulphuric Acid, 13 Weeks' Exposure

Cast iron No.	Silicon per cent.	Original weight grams.	Loss in weight, grams.	Corrosion factor.
1	1 24	56.9196	5.4512	100
2	1.29	56.6360	5.4486	100
3	1.45	57.9528	5.3868	99
4	1.55	55.4094	5.4218	99
5	1.72	56.7000	5.5454	102
6	2.04	58.6396	5.7658	106
7	2.28	57.6414	5.7614	106

Machinery and Stove Plate Iron From One Heat

By W. J. Keep

Question.—We do a small amount of jobbing work and require approximately 200 pounds of close-grained iron in every stove plate heat. Is there any alloy similar to ferro-silicon which can be added in the ladle to close the grain? The castings for which this iron is intended are attached to the ends of a steam valve and we are experiencing some trouble from small shrink holes which do not develop until after machining.

Answer.—You will not succeed in closing the grain by the addition of an alloy to the iron in the ladle. Sometimes sulphur is added to the metal in the ladle to close the grain and increase the chilling properties, but this is poor practice for general work. There is not sufficient heat in the iron after it is cast in the ladle to melt an iron compound that may be added in this way. When there is a sufficient amount of silicon in a mixture to make good stove plate, you cannot again make the iron hard. The only rational method is to have the first charge consist of the mixture which you require for this work. The tendency of first charges generally is to be close-grained and hard. Obtain a carload of No. 3 or No. 4 pig iron containing silicon about 1.25 per cent and the first charge should consist of 50 per cent of this iron and 25 per cent of No. 2 pig, with silicon about 2.25 per cent. The rest of the charge should be scrap consisting of the returns and lost castings poured from this iron the previous day. If this iron should prove to be too hard, it easily can be softened, and if too soft, it can be hardened by slightly changing the mixture. It is probable that your shrinkage difficulties will be overcome by the use of this mixture, although the employment of a chill will help you materially to overcome this difficulty. The first charge can be of any size to meet your requirements. Excess metal can be cast into grate bars or other castings in which hard iron will do no harm. Upon the charge of the close-grained mixture, place the usual charge of coke and this might be slightly increased if it seems desirable to do so. By counting the number of ladles of iron tapped out of the cupola, you can judge fairly well when all of this close-grained iron has been tapped out. However, to prevent the use of this iron in stove plate, a few additional ladles might be poured into work that is not very particular.

Table VI.

Summary of Results

Cast iron No.	Silicon per cent.	Corrosion factor in—Tap water.	Salt water.	0.05 per cent acid.	Mean factor.	Corrosion factor in 0.5 per cent acid.
1	1.24	100	100	100	100	100
2	1.29	81	92	105	98	100
3	1.45	101	95	100	100	99
4	1.55	100	99	98	100	99
5	1.72	99	101	104	101	102
6	2.04	95	101	104	101	106
7	2.28	88	88	103	96	106

Notwithstanding the high prices prevailing for tin, the increase in the world's production in the last few years has been but slight, and as compared with the output of 1910, has decreased. In 1911, the world's production of tin aggregated 118,200 tons. Although tin is used extensively in the brass foundry industry, nevertheless, the largest tonnage is consumed by manufacturers of tin plate.

An Investigation of Cupola Melting Operations

Government Tests to Ascertain the Location of the Melting Zone, Reactions of Gases and Best Methods of Charging

AT THE Pittsburgh testing plant of the United States Bureau of Mines, an exhaustive investigation of the reactions that take place in a cupola during the melting process, was recently completed and the results have been published in a bulletin prepared by A. W. Belden. Several years ago, Dr. Richard Moldenke, secretary of the American Foundrymen's Association conducted a series of tests with different grades of coke at the government fuel testing plant at St. Louis, in which especial attention was given to the melting losses that resulted from the use of various kinds of fuel from many coal fields throughout the United States. In one instance, these losses amounted to 52.5 per cent of the iron charged, and showed, in a convincing manner, the need of exact information in regard to conditions in the fuel bed of the cupola.

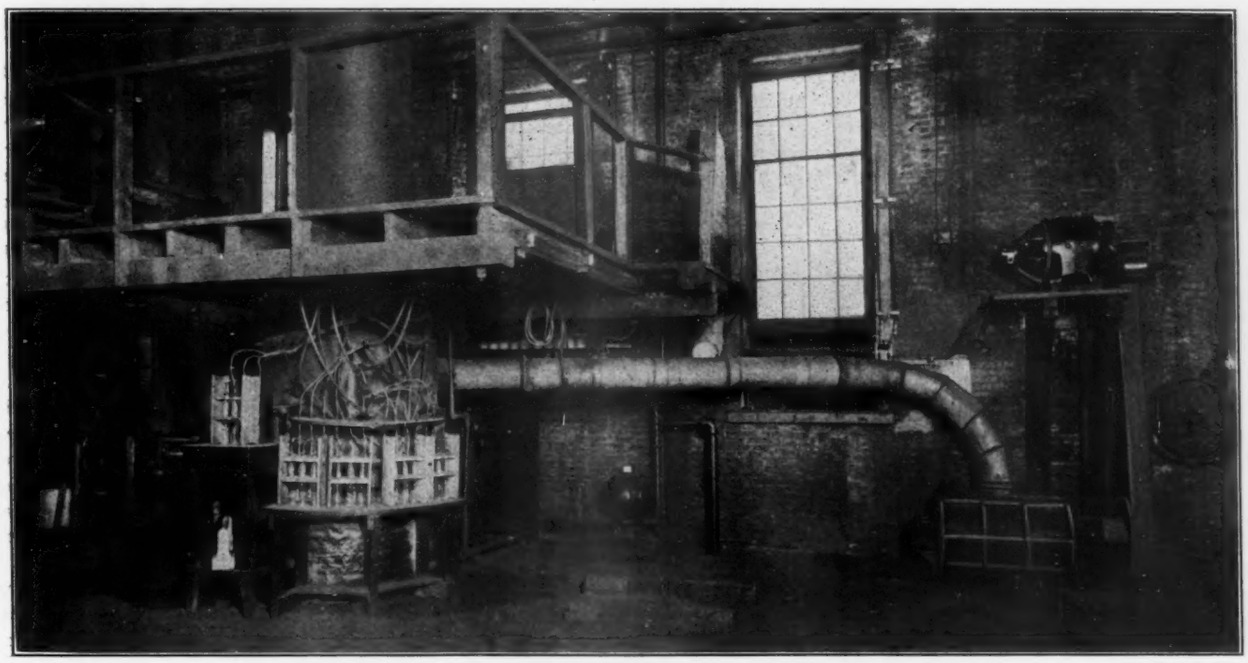


FIG. 1—CUPOLA WITH BLOWER AND CONNECTIONS

Melting losses of iron have been fully appreciated but little understood. The fact that these losses were possible with either light or heavy coke led to the belief that by using small charges so placed that melting would take place in that zone of the cupola where the highest heat and the smallest percentage of oxygen prevailed and by confining all melting to this zone these losses would be eliminated and the economical use of practically any coke produced for metallurgical purposes would become possible. This widening of the field from which coke might be drawn for foundry purposes would serve to place the foundryman in an independent position as regards his source of supply, and would tend to conserve the better grades of coking coals, which are being rapidly exhausted, by making the poorer grades available for mixing with them.

In order to investigate conditions within a cupola, the Bureau of Mines as a first step decided to install a commercial cupola, to sample the gases during their travel from the tuyeres upward, and to determine the temperature of the fuel bed.

The Cupola Used

A 36-inch standard Whiting cupola was installed. The cupola is shown in section in Fig. 4, which gives the several dimensions. Attention is directed to a few special features, as follows: Upper and lower tuyeres were provided, but the upper ones were not used in any of the tests. The four lower horizontal tuyeres measured 4 x 6 inches on the outside and 3 x 13 inches on the inside of the cupola and were 14 inches above the bottom. During tests the sand bottom was brought up to within 3 inches of the bottom of the tuyeres in order to save as much coke as possible. The tuyere area was 96 square inches, and the area of the cupola, lined to 27 inches internal diameter, was 573 square inches, a ratio of 1 to 5.96. For the purpose of the investigation the cupola was considered as divided into sections by four imaginary horizontal planes, situated as follows: One inch above the top of the inner opening of the tuyeres, and 7, 13, and 19 inches above the top level of the tuyeres. These imaginary planes, beginning at the bottom, are designated as *A*, *B*, *C* and *D*.

Two-inch holes, as shown at *a*, *b*, *c*, and *d*, Fig. 5, were cut through the wind box and inner shell along the lines at which the planes intersected the wall. Through each hole a 1½-inch pipe, 10 inches long, was passed, the inner end extending 1 inch past the inner shell into the brick lining.

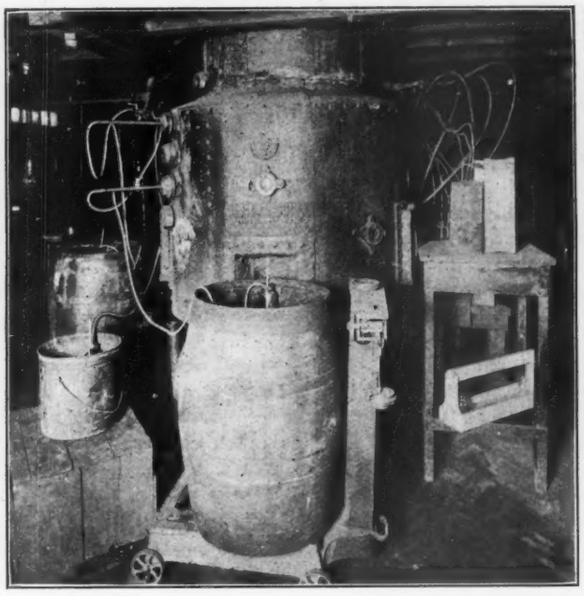


FIG. 2—APPARATUS FOR DETERMINING TEMPERATURES

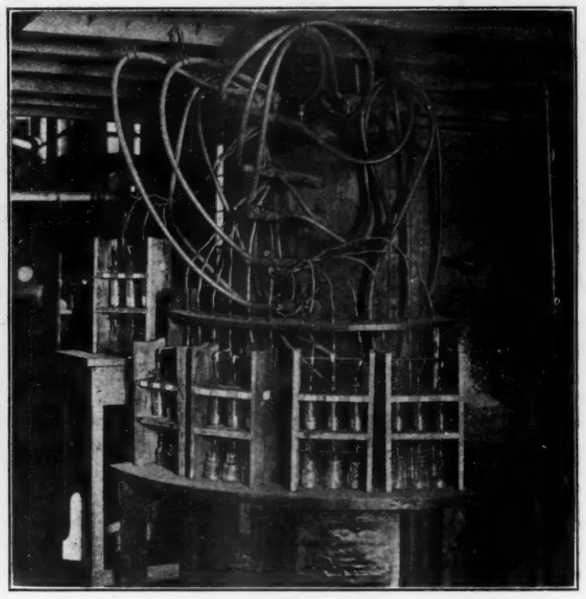


FIG. 3—APPARATUS FOR SAMPLING GASES

the outer end, extending 1 inch outside the wind box, being threaded to take a cap adapted to fit tightly the sample tube when inserted. The 1½-inch pipe was held in place and leakage of air from the wind box was prevented by lock nuts inside and outside. The lock nuts were drawn up after proper packing was inserted between the nut and the inner wall of the wind box, thus making an air-tight joint. Around the pipe at the entrance of the inner wall no packing was used, as the brick lining was cut to make a tight fit, and the sample tubes after insertion were well plastered with fire clay at the point where they passed through the brick. The pressure was not sufficient to cause leakage through to the fuel bed, and all air admitted to the cupola passed through the tuyeres. On the opposite side of the cupola at points designated as *a'*, *b'*, *c'*, and *d'* in Fig. 5, holes were cut at levels corresponding to those represented at *a*, *b*, *c*, and *d*, and were fitted with 3-inch pipes similarly to those just described. The exact location of the holes, considered with reference to the inside of the cupola, was as follows: *a* and *a'*, 1 inch above the top of the inner opening of the tuyeres; *b* and *b'*, 6 inches above *a* and *a'*; *c* and *c'*, 6 inches above *b* and *b'*; and *d* and *d'*, 6 inches above *c* and *c'*. Later tests made necessary the insertion of a fifth tube at *e* and *e'*, 7½ inches above *d* and *d'*. All of these tubes except tubes *e* and *e'* passed through the wind box. The distance of 7½ inches instead of 6 inches between *d* and *e* was necessary in order to clear the wind box and avoid the difficulty of making the joint air tight. Subsequent tests showed that this placing of the tube had no material effect on the results.

The blower and connections are shown in Fig. 1. A blower delivers a definite volume of air per revolution when running free, and the loss due to slippage is a definite and uniform quantity under any particular pressure. A reciprocating counter attached to the main shaft of the blower gave an accurate means of determining the revolutions, a Pitot tube connected to a recording pressure gage indicated the pressure at any time or the average over any period of time, and calculation gave the total volume of air delivered. In order to make the tests independent of possible delay and of overload difficulties, use of the line shaft was discontinued and a 10-horsepower motor was installed for operating the blower.

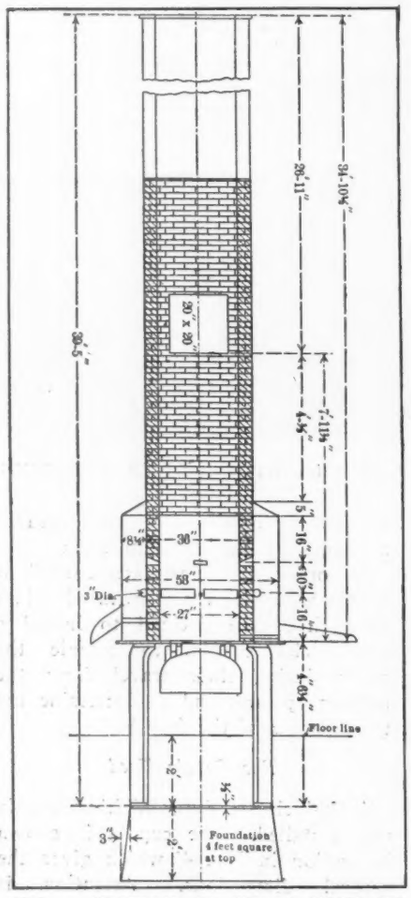


FIG. 4—SECTION OF THE 36-INCH CUPOLA IN WHICH THE TESTS WERE MADE

The blower was tested by the manufacturer at 2, 4, 6, 7, 8, and 16 ounces, and was recalibrated after installation. The curve shown in Fig. 8 was constructed to show the slippage in revolutions per minute at various pressures from 0 to 16 ounces. The amount of air delivered per revolution when running free was 4.8 cubic feet. The following example shows the method of arriving at the total volume of air delivered. During a 15-minute test the blower made 3,497 revolutions and each revolution delivered 4.8 cubic feet of air, so that the total number of cubic feet delivered was 3,497 times 4.8, or 16,785.6 cubic feet. The average pressure, as shown by a pressure gage conected with a Pitot tube inserted in the air pipe, was 5.3 ounces. The slippage of the blower at this pressure was 22 revolutions per minute. As each slippage

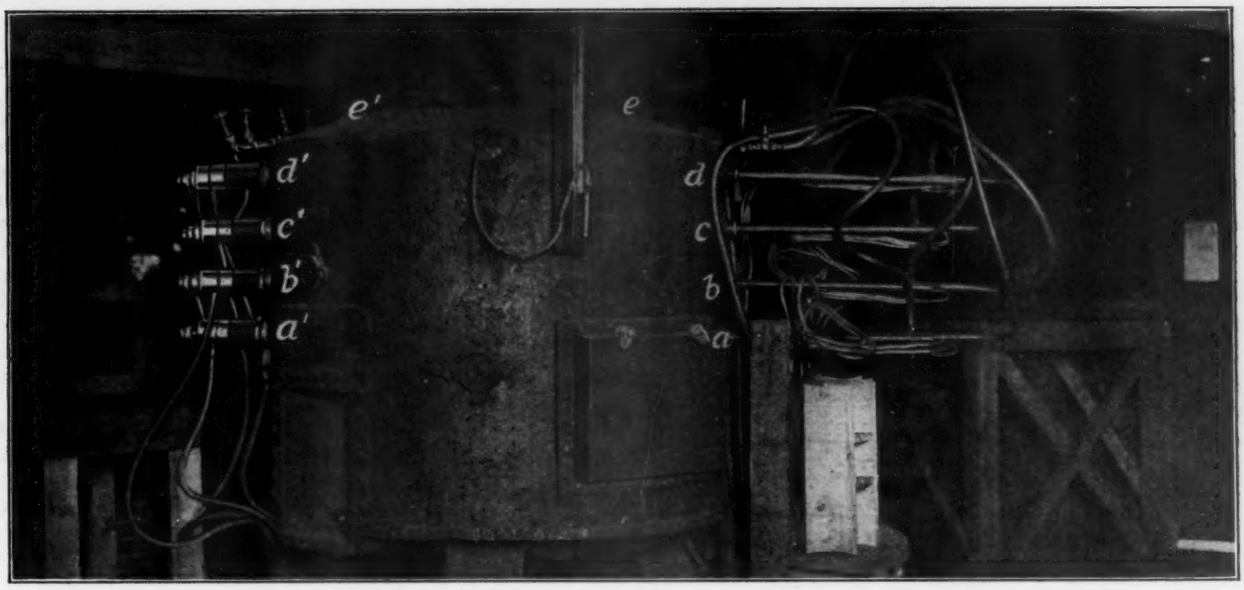


FIG. 5—LOCATION OF THE TUBES AT VARIOUS PLANES IN THE CUPOLA

revolution represented 4.8 cubic feet loss, the total loss during the test was 1,584 cubic feet (22 × 15 × 4.8). Deducting this loss of 1,584 cubic feet from the total air delivered with the blower running free (16,785 — 1,584) gives 15,201 cubic feet of air actually delivered in 15 minutes, or 1,013 cubic feet per minute.

The simple water manometer, used with the Pitot tube, required the undivided attention of an assistant, who made frequent readings over the

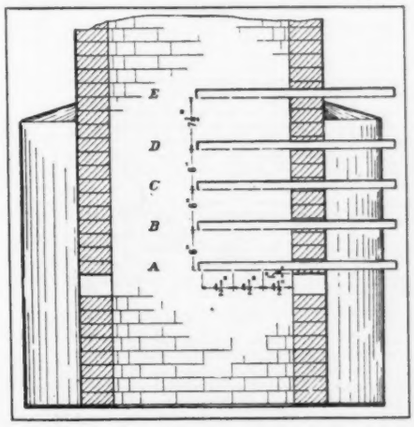


FIG. 6—POSITION OF PLANES AND GAS SAMPLING TUBES

whole period of the test in order that the average pressure might be determined. After the method of testing had been decided, a Bristol recording pressure gage, making a complete revolution in one hour, was connected with the Pitot tube. A record was thus obtained which was continuous over the whole period of the test and facilitated the determination of a true average.

In all tests, whether relating to the character of the gases or to the temperatures, the cupola was lined to 27 inches internal diameter. Coke alone, without iron or flux, was used. The investigation being designed to furnish data as to the action of the fuel, it was necessary to consider only that part of the cupola below and including the melting zone. Complications from the use of iron were thus avoided, and the experience of ordinary commercial practice does not indicate that the addition of this material would seriously affect the results obtained from coke alone. The sand bottom was brought up to within 3 inches of the bottom level of the tuyeres. The tubes for collecting gas or measuring temperature were put in position. About 24 inches of coke was placed upon sufficient wood to insure proper kindling. The fire was lighted and the coke allowed to ignite and burn until the top showed bright. Coke in small quantities was added from time to time until well above the top tube, each succeeding charge being held until the preceding charge had burned through. After the last small charge had been added, sufficient time was given to insure its burning evenly over the whole surface of the bed, thus indicating that the burning was over and through the whole bed of coke and was not localized, as sometimes happens when proper precautions are not taken. The kindling wood was always completely burned before the last coke was added. This last addition of coke brought the top of the charge to within 6 inches of the charging doors. The total weight of coke charged was approximately 750 pounds for each test. Ten minutes after the last coke had been added the blast was turned on and was continued for 15 minutes before the test began. The reason for allowing this length of time was to insure uniform conditions over the whole fuel bed, and was more than that necessary in regular commercial practice to cause the appearance of iron at the cupola spout, an indication that melting has begun.

Preliminary tests were made with varying volumes of air per minute,

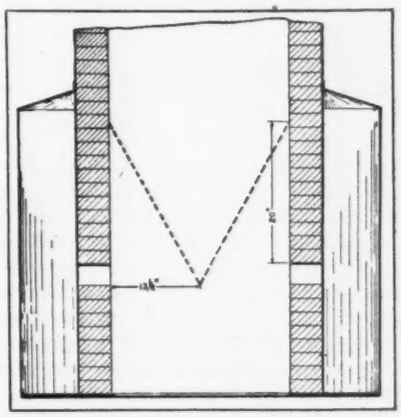


FIG. 7—SECTION OF CUPOLA, SHOWING UPPER BOUNDARY OF REGION OF COMBUSTION

the results suggesting the use of 1,000 cubic feet per minute as a normal condition. As the 36-inch cupola, lined to 27 inches, can melt about two tons of iron per hour, 1,000 cubic feet of air per minute checks well with the usual assumption that 30,000 cubic feet of air is required to melt a ton of iron. The varying pressures due to different sizes of coke, the position of pieces of coke with reference to other pieces and the side walls, the

effect of slagging and hanging and of other conditions, made impossible the exact regulation of the air supply, but the average of all tests approximated 1,000 cubic feet per minute.

In investigating the cupola gases it was necessary to decide on the best method of obtaining samples that would represent the gases in the different cross-sections of the fuel bed, and the number of such samples necessary at each cross-section, as well as the number of sections.

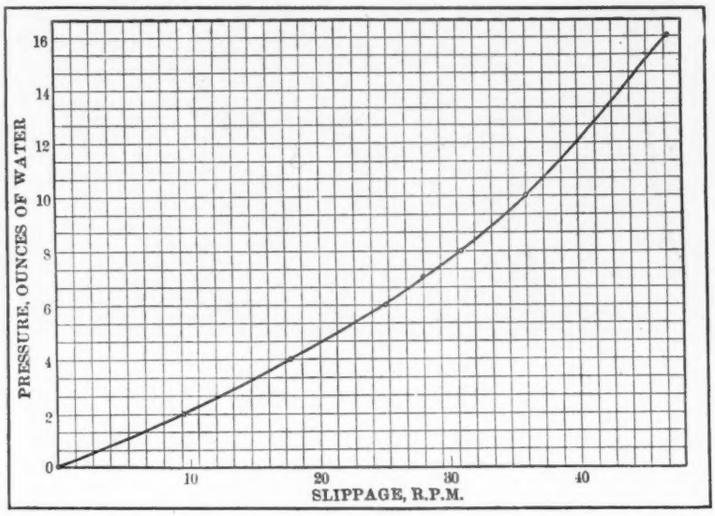


FIG. 8—DIAGRAM SHOWING SLIPPAGE OF BLOWER UNDER VARIOUS PRESSURES

Points of Sampling

It was decided to consider the fuel bed as being divided by four imaginary planes, located as follows: 1 inch above the top of the inner opening of the tuyeres, and 7, 13 and 19 inches above. In subsequent discussion these planes are designated, starting with that 1 inch above the top level of the tuyeres, as *A*, *B*, *C*, and *D*, and the points from which samples were taken, beginning with the center, as 1, 2, and 3, 2 being 4½ inches from the center, and 3 being 9 inches from the center and 4½ inches from the lining. Fig. 6 shows a vertical section of the cupola and the positions of the imaginary planes and of the sample tubes in place. All samples were taken from vertical radial planes that intersected the tuyeres, it being assumed that the gases were the same over any other similar area in the cupola because the entrance of the blast was through tuyeres, the inner openings of which extended practically the whole way around the interior circumference of the lining. Simultaneous samples taken at other points showed reasonable although not exact agreement.

The preliminary work showed the necessity of examining the bed above plane *D*, Fig. 6, so that examination was made of the gases in a fifth imaginary plane designated as plane *E*. This plane was 7½ inches above plane *D* and 26½ inches above the top level of the tuyeres.

The gas sampling tube used in this work consisted of a 1¼-inch iron pipe 48 inches long, one end closed by a circular piece of steel welded in. Three ¼ inch, 3/16 inch internal diameter, copper tubes, for the collection of the gas samples were brazed into small holes cut through the wall of the pipe and made flush with the outside. These gas collecting tubes, as well as the inclosing pipe, were kept cool by cold water which entered the outer end through a ½ inch copper tube and passed out through a ¼ inch iron pipe. The exit ends of the small tubes, as well as the ½ inch inlet, were held in place and the whole made water tight by brazing. The gas collecting tubes were connected by ¼ inch lead tubes to ¼ inch copper tubes leading into the wash bottles. The copper tubes were provided with a T at a point convenient for attachment to the mercury-filled sample receivers. The connection was made by means of a glass tube, through which a portion of the gas was drawn off continuously from the larger stream. The wash bottle was introduced beyond the point where the gas sample was taken and served to indicate whether the gas was flowing properly through the tubes. No aspiration was necessary, as the sampling tubes extended into the fuel bed and the positive pressure of the blast forced the gases through the tubes. The portion taken for a sample was drawn from the main flow by the flow of the mercury out of the gas receivers. Details of the apparatus are shown in Fig. 3.

Method of Use

The water-cooled tubes were inserted and the cooling water turned on before the cupola was charged. All of the tubes were inserted a distance that brought hole 1, or the hole nearest the inner end of the tub, Fig. 6, at the exact center of the cupola; hole 2, 4½ inches from hole 1 toward the lining; and hole 3, 4½ inches from hole 2 and 4½ inches from the lining. This placing of the tubes divided the 13½ inches from lining to center into three equal parts. When the blast was turned on, the bubbling of the water in the wash bottles attached to the ends of the tubes gave evidence of the flow of gas. If the gas did not flow properly, the small tubes were disconnected at the point where they joined the lead tube and a wire was run through to remove the obstruc-

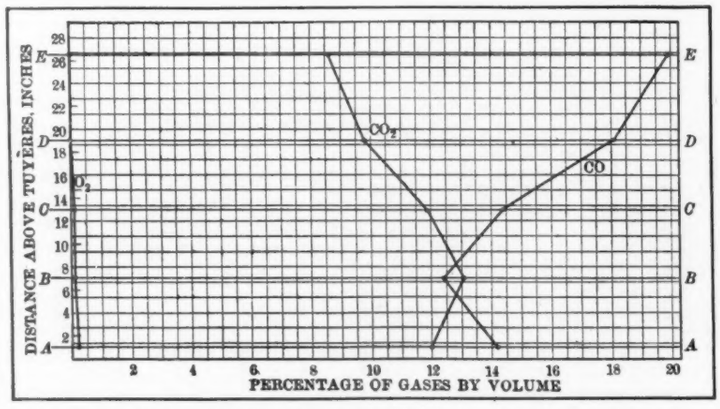


FIG. 9—DIAGRAM SHOWING VARIATION IN PERCENTAGES OF O_2, CO AND CO_2, AT DIFFERENT HEIGHTS ON THE CENTER LINE OF THE CUPOLA. LINES A, B, C, D AND E REPRESENT THE IMAGINARY PLANES

tion; or, as later practiced, compressed air was blown through from the end of the lead pipes. The latter procedure had the advantage of clearing the whole system and saved much time. After all the parts had been tested and gas was flowing freely, the mercury-filled sample receivers were attached. Fifteen minutes after the blast had been started the cocks on all the receivers were turned simultaneously and samples were taken for a period of 15 minutes. One set of three samples was taken from each imaginary horizontal plane, a total of 15 samples for each test. On several of the tests a sixth set was taken at a point above the charge, to show the average composition of the gases at that position.

Results of Analyses

The results of analyses of the gases from separate tests, as well as the average for the series, are given in Table I.

As was to be expected, samples of gas taken at different times showed many variations. The flow of the blast after entering the tuyeres was probably changing during the whole period, seeking escape inward as well as upward along the lines of least resistance. The largest volume undoubtedly flowed up the side walls, and this, as well as the part penetrating toward the center, was more or less deflected by the obstructions encountered. Effects of such changes were especially noticeable during preliminary work, when coke was charged in varying sizes as received. This explains why more uniform results are obtained in practice by the use of by-product coke or anthracite coal. During some of the first tests, in which large pieces of coke were used exclusively, oxygen persisted through the whole charge and was found in the gas sample taken above the charge. This condition was no doubt due to the fact that the large pieces of coke against the wall allowed a free and practically unobstructed passage to a part of the gases. In the tests, all coke was broken into 3-inch cubes or less. The analyses of samples of the gases present above the charge under the conditions of the tests showed no oxygen, typical analyses being as follows:

Kind of gas.	1. Per Cent.	2. Per Cent.	3. Per Cent.
CO_2	8.5	10.2	14.5
C_2	0.0	0.0	0.0
CO	20.6	17.8	8.4

Figs. 9, 10 and 11 have been constructed from Table I. The planes of the cupola from which the gases analyzed were taken are presented as ordinates and the percentages of carbon dioxide, oxygen, and carbon monoxide as abscissas. Carbon dioxide (CO_2) is the product of complete combustion. Carbon monoxide (CO) is the product of incomplete combustion. The oxygen (O_2) of the blast entering at the tuyeres comes in contact with hot coke and the burning or combustion takes place, forming CO_2. This reaction produces heat and raises the temperature. If the CO_2 comes in contact with incandescent coke it takes up carbon from the coke and changes to CO. This reaction takes up heat and reduces the temperature.

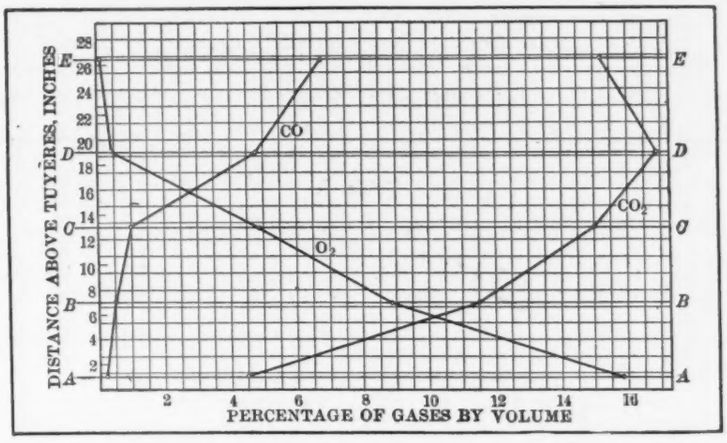


FIG. 11—DIAGRAM SHOWING VARIATIONS IN PERCENTAGES OF O_2, CO AND CO_2 AT POINTS 9 INCHES FROM THE CENTER AND 4½ INCHES FROM THE LINING OF THE CUPOLA. LINES A, B, C, D AND E REPRESENT THE IMAGINARY PLANES

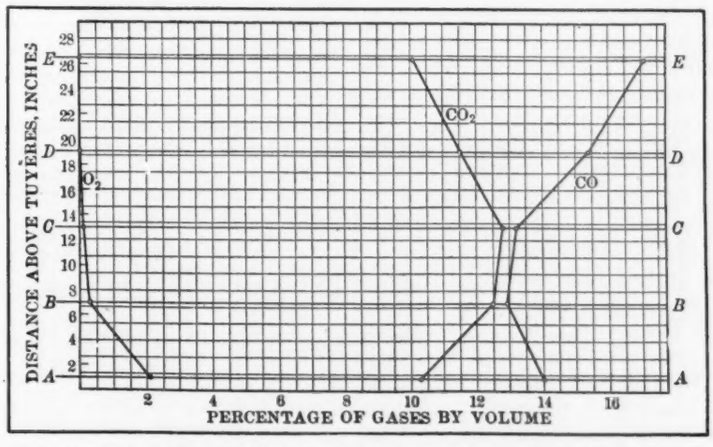


FIG. 10—DIAGRAM SHOWING VARIATION IN PERCENTAGES OF O_2, CO AND CO_2 AT POINTS 4½ INCHES FROM THE CENTER OF CUPOLA. LINES A, B, C, D AND E REPRESENT THE IMAGINARY PLANES

Gases at Center Line of Cupola

Fig. 9, representing the conditions at the center line of the cupola, shows the practical absence of oxygen at all sections, the small quantity recorded within the range of the probable error of the method of analysis or attributable to the chance penetration of some small amount of the blast. The changes taking place in the first 6 inches show an increase of CO_2, and a decrease of CO, and from this point upward a rapid falling off of CO_2, and a corresponding increase of CO.

Fig. 10 represents the conditions 4½ inches from the center and by the percentage of oxygen shown indicates the penetration of the blast at plane *A*. As shown in the illustration, the percentage of oxygen rapidly decreased, being practically nothing 6 inches above, at plane *B*. Comparing the conditions at the center and 4½ inches from the center as represented

in the illustration, the CO_2 percentages in both cases show the same general increase through the first 6 inches. At 4½ inches from the center there is no material change during the movement through the second 6 inches. From this point upward through the fuel bed the percentage of CO_2 at 4½ inches from the center decreases, but not so rapidly as the percentage at the center. The CO percentage at 4½ inches from the center decreases in the same general manner as the CO at the center during the passage of the gases through the first 6 inches. Through the second 6 inches no material change takes place. From this point up through the bed the proportion of CO at 4½ inches increases but not so rapidly as that at the center.

Table I.

ANALYSES OF CUPOLA GASES.

Plane. *a*	Location No. *b*	Test No. 1. CO_2	O_2.	CO.	Test No. 2. CO_2.	O_2.	CO.	Test No. 3. CO_2.	O_2.	Co.	Test No. 4. CO_2.	O_2.	CO.	Test No. 5. CO_2.	O_2.	CO.	Average. CO_2.	O_2.	CO.
A	1	5.9	0.0	25.1	8.8	0.0	19.5	17.1	0.7	4.9	16.8	0.3	6.0	11.6	0.0	15.5	12.0	0.2	14.2
	2	10.3	9.5	1.6	10.3	0.1	16.9	11.0	0.4	15.5	6.0	0.5	24.2	13.8	0.1	11.6	10.3	2.1	14.0
	3	1.1	19.6	0.0	2.5	18.1	0.0	3.1	17.6	0.0	9.5	10.6	1.1	7.3	13.1	0.3	4.5	15.8	0.2
B	1	7.9	0.0	21.3	15.6	0.5	8.3	12.2	0.0	14.0	14.0	0.0	11.1	15.6	0.3	7.5	13.1	0.1	12.4
	2	18.3	1.3	1.7	11.8	0.1	14.7	13.1	0.3	12.0	9.2	0.0	18.8	10.3	0.0	17.2	12.5	0.3	12.9
	3	10.4	10.1	0.1	14.0	6.2	0.7	8.1	12.4	0.0	12.4	7.8	1.1	12.7	7.8	0.4	11.5	8.9	0.5
C	1	7.0	0.0	23.2	13.9	0.2	10.9	12.9	0.0	13.1	11.7	0.0	14.7	14.1	0.5	10.1	11.9	0.1	14.4
	2	15.0	0.2	8.6	14.2	0.0	13.1	13.8	0.2	11.2	8.2	*c*0.7	19.7	....	....	....	12.8	0.1	13.2
	3	15.2	4.9	0.4	15.0	4.7	1.5	13.2	7.3	0.5	16.6	2.8	1.2	15.1	4.8	1.4	15.0	4.9	1.0
D	1	6.3	0.0	24.0	11.3	0.0	15.3	10.8	0.0	16.3	9.1	0.0	18.9	11.4	0.0	15.8	9.8	0.0	18.1
	2	12.1	0.0	14.8	11.0	0.1	15.8	13.3	0.1	12.3	9.1	0.0	19.8	12.1	0.0	14.2	11.5	0.0	15.4
	3	17.6	0.7	4.1	17.0	0.7	4.9	16.9	*c*2.6	1.8	16.5	0.1	6.9	16.6	0.2	6.4	16.9	0.4	4.8
E	1	6.7	0.0	24.1	9.5	0.0	18.3	10.1	0.0	17.3	7.1	0.3	21.5	9.7	0.0	18.1	8.6	0.0	19.9
	2	10.6	0.0	16.6	10.4	0.0	16.7	....	....	....	8.5	0.0	19.0	10.9	0.0	16.0	10.1	0.0	17.1
	3	16.5	0.3	6.8	15.8	0.0	7.8	16.8	0.0	5.4	12.1	0.2	14.1	14.9	0.0	8.8	15.2	0.1	6.8

a Refers to imaginary horizontal plane.
b Refers to holes in sampling tube.
c Probably due to channel flow of air; not included in average.

Gases Nine Inches From Center Line

Fig. 11 represents the conditions 9 inches from the center and 4½ inches from the lining. One inch above the tuyeres the oxygen of the blast is reduced by an amount necessary to form 4.5 per cent CO_2, and the formation of CO_2 rapidly increases in the first 6 inches, with corresponding decrease in O_2 and with little formation of CO. These conditions indicate a fierce burning and a great rise in temperature. This assumption is borne out by the rapid rise of the temperatures at plane *B* as compared to the temperature at plane *A*.

From plane *B* the oxygen rapidly decreases to practically nothing just above plane *D*. The CO_2 remains practically constant from plane *B* to plane *C*, the CO increasing slightly. During the passage of the gases through the next 6 inches both CO_2 and CO increase. This zone of highest CO_2 content, as yet not materially affected by the rise of CO, is the hottest part of the entire fuel body. From this point to the next plane (*E*) 7½ inches above, the CO_2 decreases and the CO increases, while the temperature decreases.

The temperature conditions at plane *E* and at plane *C* are nearly the same, but the conditions for melting are materially different. At plane *C* there is a supply of oxygen that would undoubtedly cause oxidation of the metal and resultant loss. Whether the amount of iron melted at this plane would be oxidized sufficiently to affect seriously castings made from the whole tonnage was not determined by these investigations, but if certain conclusions, based on the tests at St. Louis, as to the effect of burned metal on casting are correct, it is safe to assume that the chances favor the production of defective castings.

The broken line in Fig. 7 represents the upper boundary of the region of gases containing free oxygen. The actual combustion of the fuel takes place in the fuel bed around a region having the shape of an inverted cone; the apex of this cone is at the center on the level of the bottom of the tuyeres and its surface flares out to the lining at a point 20 inches above. If melting be kept above the base of this cone, no oxidation will occur.

Considering the region of gases highest in CO_2 content and devoid of O_2 and considering the plotted line of highest CO_2 content at each plane as a line of demarcation, the line *ab* in Fig. 14, shows in cross-section the probable shape of the top of the fuel bed as defined by the points of highest temperature.

If it were possible so to charge the cupola that melting would take place along or just above such a line (or, rather, surface) as is indicated in this illustration, ideal results would be obtained both as regards temperature and absence of oxidation. Since it is not possible to confine the melting to this irregular region, the best condition for melting is obtained at that section across the whole of the fuel bed that shows the highest temperature together with absence of oxygen. This condition, as shown by the tables of temperatures and of analyses of the gases, exists just above plane *D*, about 20 inches above the tuyeres. It is not possible to do all melting at this particular plane, but the melting can be so confined and regulated that none takes place below this plane.

Probable Line of Highest Temperature

The height of the melting zone above this plane is determined by the physical condition of the coke and the rate of heat absorption of the iron. If the coke is porous, the charges of iron should be small to prevent the coke burning out and letting the iron down into the oxidizing zone before melting is accomplished. If the coke is heavy and dense, or if anthracite coal is used, the charges may be made larger, as the fuel will burn more slowly and give a longer time for melting. In some region above this zone of highest temperature the temperature is still high enough to melt iron but is not high enough to impart heat quickly and to give hot iron. This melted iron passes through the lower zones, although the temperature in these zones be exceedingly high, too rapidly for the absorption of enough heat to raise its temperature mater-

Table II.

ANALYSES OF GASES FROM CUPOLA OF BOSHED CONSTRUCTION.

Plane.	Location No.	CO_2. Per ct.	O_2. Per ct.	CO. Per ct.
A	1	11.1	1.0	14.3
	2	0.3	20.4	0.0
	3	0.2	20.7	0.0
B	1	14.8	1.2	8.4
	2	11.1	9.3	0.0
	3	2.2	18.4	0.0
C	1	14.6	0.0	10.6
	2	16.0	4.0	0.7
	3	5.4	15.2	0.3
D	1	10.3	0.0	17.3
	2	15.7	0.0	8.0
	3	16.9	3.3	0.7
E	1	7.5	0.0	21.9
	2	13.2	0.0	12.5
	3	17.1	0.5	4.7

ially, and cold iron is the result. The experiments here reported confirm the general opinion that the hottest part of the cupola is where the lining is most burned out. A curved line drawn to represent the burned-out lining corresponds closely with the curves drawn to represent the heat absorbed at the several planes previously described.

Table III.

TEMPERATURES, DEGREES FAHR.[a]

Plane. A	B	C	D
2,736	2,827	(b)	2,827
c2,862	(b)	(b)	(b)
2,653	2,966	2,934	2,786
2,712	(b)	3,015	2,741
2,742	3,036	2,988	2,692
(b)	c3,083	(b)	(b)
2,742	2,939	c3,052	c2,961
2,800	2,811	3,009	(b)
d2,750	d2,942	d3,000	d2,802

[a]All temperatures taken at center of cupola with Wanner optical pyrometer at intervals of 2 minutes.
[b]Cold, not included in total.
[c]Maximum.
[d]Average.

Alteration of Cupola Lining

A study of the data shown in Table I led to the conclusion that the amount of coke necessary for melting could be reduced by changing the lines of the cupola from the straight to the boshed form. Accordingly the lining was drawn in to 23 inches at the tuyeres, tapered to the original lines of 27 inches at 15 inches above the tuyeres, and continued straight from this point. It was thought that the blast entering at the tuyeres would penetrate farther toward the center of the cupola and a smaller volume of air would escape up the side walls without first coming in contact with hot coke. This, it was hoped, would cause the loss of all the oxygen at a lower point in the fuel bed and would lower the zone at which the iron could be melted without its quality being seriously affected. The zone of highest temperature was expected to follow the zone where oxygen disappeared, as in the case of the straight lining, but no attempt was made to determine whether this relation held.

Table IV.

TEMPERATURES, DEGREES FAHR.[a]

Plane. A	B	C	D	E
2,584	b3,027	2,993	2,579	2,856
2,763	2,939	b3,020	2,674	2,786
2,988	2,809	2,925	2,871	2,696
3,020	2,804	2,851	2,570	2,763
2,826	2,971	2,809	2,856	b2,914
b3,067	2,752	2,687	b2,908	2,883
3,060	2,817	2,809	2,826	2,800
2,939	2,773	2,593	2,692	2,800
3,033	2,678	(c)	2,766	2,817
2,671	2,790	(c)	2,874	2,680
2,790	2,955	2,851	2,889	2,797
2,899	2,851	2,674	2,719	2,755
2,934	2,817	(c)	2,730	2,851
d2,890	d2,845	d2,822	d2,766	d2,800

[a]All temperatures taken at center of cupola with Wanner optical pyrometer at intervals of 1 minute; 2-inch clay protecting tips on ends of water-cooled tubes.
[b]Maximum.
[c]Cold; not included in total.
[d]Average.

Table II shows typical analyses of gases sampled after alteration of the lining, but taken from the same location as were the gases whose analyses appear in Table I.

The penetration of oxygen was affected, as may be seen by comparing the analyses with those of Table I, but the oxygen persisted up through the whole bed. The analysis of the gas at the point represented by D3 of the table shows 3.3 per cent O_2, as compared with 0.4 per cent at the corresponding location with the original straight lining, Table I. Drawing-in the lining materially increased the blast pressure (from 3.6 to 5.5 ounces), and the flow of gas was accelerated to such an extent that the time of contact with the coke was not sufficient to rob the blast of its oxygen.

Table V

HEAT ABSORBED PER MINUTE AT DIFFERENT LOCATIONS IN THE FUEL BED, B. T. U.

Plane.	Location.	Length of tube exposed. Inches.	Test No. 1.	2.	3.	4.	5.	6.	Average.
A	1	13½	347.8	304.0	351.2	311.8	292.4	399.4	334.4
	2	9	191.1	161.7	163.3	222.3	199.3	189.5	187.9
	3	4½	20.4	19.5	38.2	21.4	27.7	22.6	25.0
B	1	13½	495.1	506.0	594.1	514.5	559.0	534.5	533.9
	2	9	339.4	344.9	363.1	315.7	343.2	385.1	348.6
	3	4½	158.8	131.4	144.0	118.9	155.1	128.6	139.5
C	1	13½	612.0	615.0	.....	541.3	545.9	625.2	587.9
	2	9	362.2	399.0	450.2	457.5	456.8	460.3	431.0
	3	4½	110.3	178.5	186.1	189.8	220.1	238.7	187.3
D	1	13½	598.5	.....	606.4	623.3	582.7	651.4	612.4
	2	9	453.3	466.3	449.4	472.0	432.6	449.0	453.8
	3	4½	238.9	242.3	229.6	236.8	243.9	.....	238.3
E	1	13½	613.8	587.7	558.6	572.5	609.0	614.5	592.7
	2	9	400.8	425.3	407.0	401.0	401.6	386.1	403.7
	3	4½	244.0	242.1	255.0	202.7	248.1	.....	238.5

Use of Optical Pyrometer

The next step was an attempt to obtain temperatures with an optical pyrometer by observation through a water-cooled iron tube with a glass-covered opening at one end. It was fully appreciated that the readings obtained would not represent actual temperatures on account of the cooling effect of the water-cooled tubes, but it was hoped that approximate temperatures showing the temperature differences between planes would be obtained and that they would be expressed in degrees of temperature with an explanation as to the limitations of the method. It was thought that at any given point the highest reading obtained during the whole period of the test would approximate the true temperature at that point. However, the averages of five temperature readings made at each of five points at different heights on a vertical line at the center of the cupola proved to be practically the same as were the highest temperature readings at each of the points. It was thought that the true temperatures at the center of the cupola might possibly be as uniform as these readings indicated, since no analysis of the gases taken at any time showed an appreciable amount of oxygen, and therefore indicated that there was no combustion. Further tests with the ends of the tubes at varying distances from the side wall continued to show for all points in any vertical line practically the same average temperature and the same high temperature. It was thought that this condition might be due to the fact that the ends of the water-cooled tubes were in direct contact with the coke.

Measuring temperatures in the fuel bed of the cupola presents many difficulties and all attempts to get actual temperatures failed. Descriptions of the several forms of apparatus used in the various tests here reported are given somewhat in detail for two purposes: (1) To draw attention to the many difficulties encountered during this part of the investigation, and (2) to render these experiments more serviceable to future investigators. Diligent search of all available literature failed to reveal accounts of attempts to determine the actual temperature in the interior of the fuel bed of the cupola or in other metallurgical operations on the same scale. Measurements have been attempted

at points on or near the furnace walls, but not at points over a considerable cross-sectional area.

It was first decided to take temperatures by means of platinum-rhodium thermo-couples introduced into the fuel bed through clay tubes. The thermo-couples were so placed that readings were obtained at the center of the cupola at a point 4½ inches from the center toward the lining and at a point 9 inches from the center and 4½ inches from the lining. The positions of the points are the same as those from which gas samples were taken. The tubes were specially prepared from mixtures of the most highly refractory clays that could be obtained. In plane *A*, just above the tuyeres, the tubes stood up well, and direct readings of temperature were obtained.

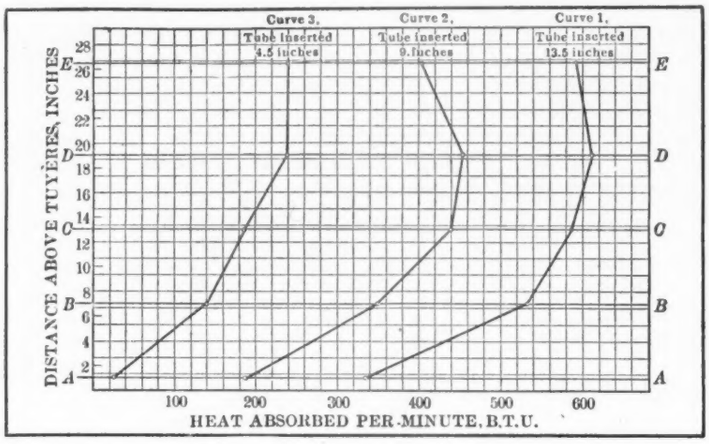


FIG. 12—DIAGRAM SHOWING VARIATION AND NUMBER OF B. T. U.'s ABSORBED AT DIFFERENT HEIGHTS IN THE FUEL BED. LINES A, B, C, D AND E ARE THE IMAGINARY PLANES

Discussion of Results

With the hope of further perfecting the apparatus, a clay protecting tip was placed over the end of each of the water-cooled tubes, extending a distance of 2 inches. This made possible the reading of the temperature of coke that was not in direct contact with the water-cooled tubes. These protecting tips were melted, like the clay tubes, but held up long enough to show the same uniform readings as with the unprotected tubes.

Tables III and IV show typical readings of temperatures taken through water-cooled tubes with an optical pyrometer.

A tube was finally adopted as a device for determining the amount of heat absorbed per minute at different depths in the fuel bed. A ¾-inch copper tube, 32 inches long, was closed at one end by welding in a circular piece of steel. A ¼-inch tube inserted at one end and extending to the farther end provided a means for circulating water through the tube. This tube was inserted different distances into the fuel bed and the heat absorbed was determined. The flow of water was kept as nearly constant as possible. The average amount for each test was 150 pounds in all, or 10 pounds per minute. The temperature of the inlet and outlet water was obtained by means of mercurial thermometers. Readings of the temperature of the inflowing and outflowing water were made each minute during a test. These readings were separately averaged. The difference between the average temperatures over a definite period multiplied by the total weight of water circulating through the tube during that period gives the total heat absorbed. This total divided by the total number of minutes of the test gives the heat absorbed per minute. Fig. 15 shows how the tubes were placed in the cupola. The copper tubes were thoroughly cleaned before each test and the conditions were made as uniform as possible in all respects. Only two tubes were used during any one test. They were placed at least 12 inches apart in order to prevent a possible reduction of temperature by radiation of heat from coke surrounding one tube to the other tube if the two were in close proximity.

Results With Water-Cooled Tubes

Table V shows the heat absorbed per minute at the different planes. The tubes were inserted in the fuel bed to distances corresponding with the points from which the gas samples were taken. For location 1 of the table the tube was inserted 13½ inches (from the lining to the center of cupola); for location 2, 9 inches; and for location 3, 4½ inches.

The heat measurements by the copper tubes show the heat absorbed by the tubes over the whole distance to which they were inserted and not the heat at some particular point in the fuel bed. As in the case of the gas analyses, the observations varied considerably. Allowance being made for the crudeness of the method, the variations are not surprising. Figs. 12 and 13 show graphic representations of the results.

Fig. 12 gives a graphic representation of the averages of the observations at each location, which are believed to show the relative temperatures of the several planes measured. The heat absorbed per minute is shown as abscissas and the heights (planes) as ordinates. From this figure it will be noted that the greatest amount of heat was absorbed at plane

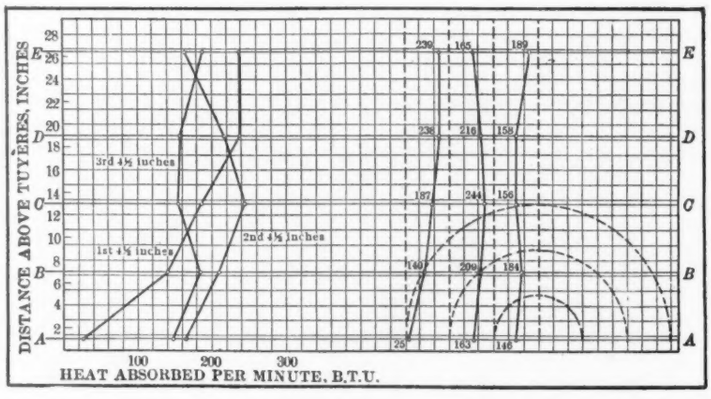


FIG. 13—DIAGRAM SHOWING VARIATION AND AMOUNT OF HEAT ABSORBED PER MINUTE IN DIFFERENT REGIONS OF THE CUPOLA FUEL BED

D. At plane *A*, with tube inserted 4½ inches, the cooling effect of the blast is evident, the heat absorbed being small. As the height above the tuyeres increases the temperature steadily increases up to plane *D*, Curve 1, representing the heat absorbed in each section when the tubes were inserted over the whole radius of the cupola, shows that the height above the tuyeres where the greatest heat existed over the whole cross-section of the fuel bed was at *D*, 19 inches above the tuyeres.

The heat absorbed in each plane of the cupola is shown by the curves in Fig. 13. The figures representing the heat absorbed in the first 4½ inches from the lining are direct determinations.

The figures for the second 4½ inches are obtained by deducting the amount found for the first 4½ inches from the amount found for 9 inches, and for the third 4 inches by subtracting the amount found for the 9

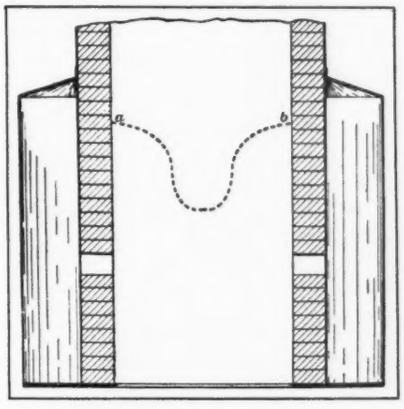


FIG. 14—PROBABLE LINE OF HIGHEST TEMPERATURE

inches from the total for the whole 13½ inches. In the zone between the lining and a line 4½ inches within, the temperature increased rapidly through the lower 19 inches. Through the next 7½ inches it was practically unchanged.

A comparison with the gas curve shown in Fig 11 shows that the temperature followed the increase of CO_2 to plane *D*, 19 inches above the tuyeres. Through the next 7½ inches the CO_2 fell off though the temperature was constant, the amount of CO formed seemingly not absorbing enough heat to reduce the temperature. In the region included between lines 4½ and 9 inches distant from the lining the temperature increased to plane *C*, 13 inches above the tuyeres, and fell off from this point upward. This temperature curve, when compared with the gas curves presented in Fig. 10, shows that the increase of heat followed the increase of CO_2 up to plane *C;* then fell rapidly through the next two planes as the CO rose. In the third region, included between lines 9 and 13½ inches from the lining and representing the central part of the cupola, the temperature rose through the first 6 inches, fell off through the second 6 inches, remained constant through the next 6 inches, and finally increased rapidly through the last 7½ inches. Comparing this curve with the gas curves of Fig. 9, the temperature curve is found to follow the CO_2 curve through the first 12 inches. From this point up through the remaining 13½ inches of the fuel bed, the temperature would be expected to fall considerably since the CO_2 decreases and the CO increases. The actual determination of the heat absorbed shows the reverse to be true. The rapid change of CO_2 to CO absorbed heat and cooled the central part of the cupola below the surrounding portions. The flow of heat from the hotter to the cooler portion increased the temperature of this central part.

As it was not possible to make true temperature measurements at the several points corresponding with the points from which the gas samples were taken, it is not possible to confirm the probable location of the points of highest temperature as shown in Fig. 14. However, by the use of the curves shown in Fig. 12, it is possible to confirm the conclusion that the best melting zone is where the highest temperature and an absence of oxygen exist throughout the whole cross-section of the fuel bed. An examination of the curves shows that the region of highest temperature corresponds with that region where oxygen is entirely absent across the whole cross-section. This region is about 19 inches above the tuyeres.

The ideal melting region probably corresponds to that lying along and just above the line *ab* of Fig. 14, This line includes points in the illustration representing those points in the cupola having highest carbon-dioxide content together with an absence of oxygen, as determined from analysis of the gases. It is manifestly impossible to confine melting to such a region, and the logical conclusion from the experiments here reported is that the best results are obtained if the iron is melted at that region in the cupola where the highest temperature, together with an absence of oxygen, exists across the whole fuel bed. The bottom of this region in the cupola tested was 19 inches above the tuyeres when 1,000 cubic feet of air per minute was being blown. This region will be raised if the blast is increased and be lowered if the blast is reduced. Experimental determination of this region is not necessary. In practice, the bellying-out of the lining of the cupola is a perfect index of the position of the melting zone, and this bellying is in the region where temperature is highest and oxygen is absent.

Melting Zone

Care must be taken not to melt below the bottom of this region, for the oxygen of the blast not being entirely removed, the iron will be oxidized or burned. The extent of this burning is dependent on the distance below the proper melting region and the lateral position in the fuel bed. Just below the bottom of this melting region oxygen is still found at the lining and the cross-sectional area

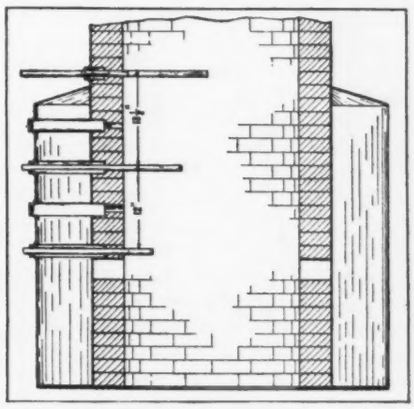


FIG. 15—SECTION OF CUPOLA, SHOWING LOCATION OF WATER-COOLED COPPER TUBES

of this oxidizing region increases as the distance downward increases until the whole cross-section at the tuyeres shows the presence of this damaging element. The whole problem of obtaining hot iron, free from effects due to oxygen, is solved by using small charges evenly distributed on the fuel bed, and confining the melting to a few inches above the plane shown by the burning-out of the lining to be the hottest plane of the fuel bed. If the first charge of iron is so placed that melting begins, say, 4 to 6 inches above this plane and is completed before any of the iron gets below it, and if the following coke and iron charges are so regulated as to maintain this melting zone, the best possible results will be obtained.

The experiments here reported indicate further that the use of upper

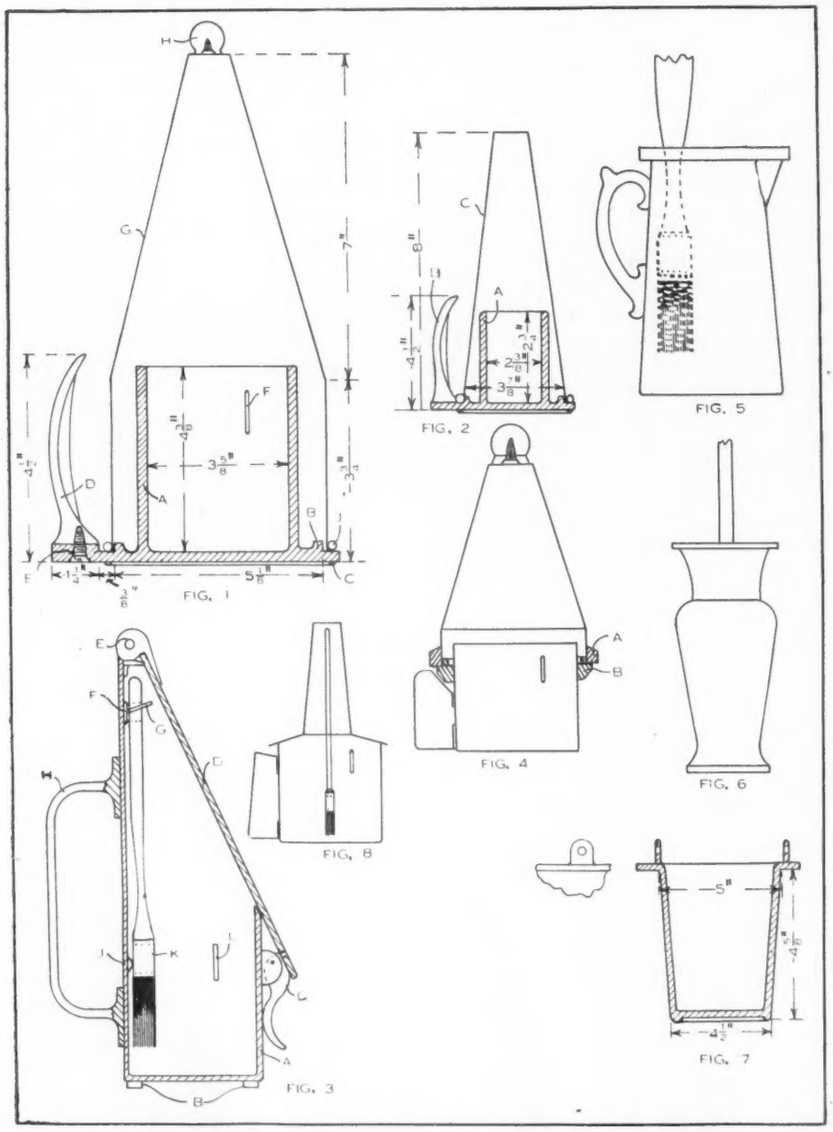
tuyeres is not only unnecessary, but a positive detriment to the production of the best iron. The introduction of air into the fuel bed above the tuyeres, even though in small volume, increases the liability of injurious effect from oxygen and serves no useful purpose. The increased tonnage supposed to be obtained by the use of upper tuyeres can be produced just as easily by blowing through the bottom tuyeres the proper volume of air.

Shellac Pots for the Pattern Shop

By H N Tuttle

WHILE it seems doubtful if the ideal shellac pot ever will be designed, yet the ordinary pot used in the majority of pattern shops is by no means satisfactory. In the accompanying illustration, Fig. 8 shows a type of pot used extensively. It is made of sheet copper and is provided with an extension cover for the handle of the brush. This pot soon becomes gummed-up around the edges and the cover, consequently, will not fit tight and considerable evaporation results. On the other hand, if not used for a certain length of time, the cover sticks so tightly that it is almost impossible to remove it.

In some shops a china water pitcher with a flat top, as shown in Fig. 5, is used. The cover consists of a piece of flat board, notched out for the brush handle. This type of pot is easily cleaned, does not discolor the varnish and can be cheaply made. These, however, are its only recommendations. The pot shown in Fig. 4 has a joint made of two brass rings, one soldered onto the cover and the other onto the pot. The bearing between the two is machined so that there will be at least 1/32 inch between the surfaces to provide a loose fit. The bearing extends away from the can about ⅛ inch, so that the varnish, which is dropped accidentally over the edge, will not fall onto this surface. A can designed with a holder for suspending the brush, is shown in Fig. 3. The rib, *F*, is provided with two or three pins, *G*, from which the brushes are suspended, the pins passing through holes in the handles. This pot is rectangular, which permits hanging two or three brushes side by side. The narrow rib, *J*, prevents the brushes from touching the side of the can. The cover is made of ⅛-inch sheet steel or cast iron. The eccentric lever, *C*, is placed between two ears, as indicated, so that the cover always can be raised, regardless of the amount of gum between the cover and the side of the can. The handle for carrying the pot is shown at *H*, while the four lugs, *B*, prevent the bottom from wearing.



SHELLAC, VARNISH AND GLUE POTS FOR THE PATTERNMAKER

The cast iron pot, Fig. 1, possesses many advantageous features. Fig. 2 shows a similar pot for the red or black varnish used for core prints. In every well-regulated shop each patternmaker should have a shellac pot at his bench. The dimensions given, of course, can be varied proportionately, according to the size of the pot to be made. In Fig. 1, *A* is a cast iron pot, approximately ⅛ inch thick, and *B* is a rib for centering the cover, *G*. This construction permits the varnish, which flows over the top edge, to fall into the groove between the rib and the edge of the pot and prevents it from falling onto the joint. The cover, *G*, may be made of tin or galvanized iron. The handle, *D*, is cast iron and is held in position by the countersunk screw, *E*, and by a cast rib on either side.

This type of pot possesses many advantages in that the cover is always loose, although the joint is sufficiently tight to prevent evaporation almost entirely. Also, the pot is heavy, so that it is practically impossible to accidently knock it over. As the pot is made of cast iron, it will not corrode, and when it is to be cleaned, it can be thrown into a metal patternmaker's fire or into a blacksmith's forge and it will be burned clean in a few moments.

Fig. 6 shows a bottle utilized as a pot with a brush handle extending through a leather disc used as the cover. This makeshift pot frequently is used when a small amount of thick varnish is required for attaching leather fillets or metal figures to patterns. A cast aluminum glue pot, which has given satisfactory results, is shown in Fig. 7.

Report of the Congress of French Foundrymen

Concurrent With This Meeting in Paris Was Held an Exhibit of Foundry Supplies and Equipment—Proceedings of the Association Technique de Fonderie

Special Staff Correspondence

THE association movement among foundrymen in France has grown rapidly in recent years and the interest manifested in organization work was reflected by the largely attended congress held in Paris from May 26 to 31 under the auspices of the Association Technique de Fonderie. This French society practically dates from 1911, at the end of which year there were 81 members. Twelve months later the enrollment had been increased to 145 and at the present time the membership is 300. Its objects are similar to those of the American and British Foundrymen's Associations, although full membership is reserved to the principals and proprietors of foundries, the associate members comprising exclusively managers and other members of the executive staff. Concurrent with the congress was held a large exhibition of foundry supplies and equipment which did not terminate until June 1, to afford the foremen and molders employed in Paris foundries an opportunity to attend the show. There was a total of 73 exhibitors and in size, the exhibit compared favorably with those conducted by the Foundry & Machine Exhibition Co. in the United States.

Competitive Papers

The professional sessions of the congress were held in the National School of Arts and Crafts. At the opening session Camille Didier, secretary, recounted the history of the society and mentioned as noteworthy examples of the work already accomplished the two open competitions for papers on foundry practice that had been had. One was on the practical study of foundry cupolas, in which the winners were Messrs. Desquenne and Gueneau. The winner of the prize for a competitive paper entitled "A Study of the Minor Phenomena Which Takes Place in Molds" was Yvan Lamoureaux.

The congress was admirably organized by E. Ronceray, of Ph. Bonvillain & E. Ronceray, molding machine manufacturers, Paris. Mr. Ronceray is treasurer of the French association and also acted in the capacity of secretary to the congress. Approximately 250 members and visitors were registered during the first three days of the meeting, many delegates having come from England, Scotland, Italy, Germany, Holland, Norway, Belgium and Spain. From the United States the only delegate present was the representative of THE FOUNDRY. The exhibits included every appliance used in foundry work and many molding machines were displayed, the exhibit of Ph. Bonvillain & E. Ronceray having been particularly noteworthy. A large amount of machinery used in the preparation of sand also was shown, as this practice in French shops has reached a high state of perfection. France is not so abundantly provided with deposits of molding sand as the United States, and for this reason primarily the foundrymen have been compelled to resort to the use of machinery in the preparation of their sand mixtures. Not only is the sand consumption greatly reduced thereby, but castings are made which have an unusually fine finish and for which the French foundrymen are noted.

E. RONCERAY

Treasurer of the French Foundrymen's Association and Secretary of the recent congress

Many visits were made to foundries in the Paris district, the works of Colin & Co. having proved particularly interesting. This plant employes approximately 2,000 workmen, and is engaged in the manufacture of light castings exclusively. Several malleable shops also were visited.

Professional Sessions

In the preparation of the program an effort was made to have it international in scope, and as a result papers by authors from the United States, England and Spain were presented. A. L. Curtis, of England, presented a paper dealing with foundry sands and their treatment and he pointed out that microscopic study was essential to a proper understanding of the subject. Next in importance to the microscopic examination of sand he directed attention to the necessity of some rapid method of analysis for daily use. An important test, he said, was the determination of the average fineness of the sand. The determination of the refractory qualities of sand, he said, was best made by means of an oxy-acetylene blowpipe and a Fery recording pyrometer. The samples should be about 3 inches long, ¾ inch wide and 1 inch thick at one end, diminishing to 1/18 inch at the opposite end. In ordinary practice one or two samples were usually found to be sufficient to determine the refractory qualities. If intended for steel castings, however, the material should be subjected to the further test of being made into small molds for a trial cast. In both instances the sample should be baked in a muffle furnace before testing. The author described an instrument for determining the density of the sand or its compressibility in a mold of given size and also an apparatus of his own invention for determining the plasticity of the sand. By the use of the latter instrument a mixture

having a good chemical composition and good refractory qualities, but with low cohesion, could be detected and modified so as to strengthen it.

W. H. Hatfield presented a paper entitled "Cast and Malleable Iron", in which he compared the European with the American or black-heart process. He pointed out that the essential difference between these two processes is that in the European or Reaumur system of malleableizing decarburization is depended upon to a considerable degree, whereas the American system depends mainly upon breaking down the carbide into annealing carbon. This difference, he said, can be traced directly to the low sulphur content of the iron available in America.

M. J. Lambot discussed "Melting and it is becoming increasingly difficult to interest young men in foundry operations. Dr. Rosenhain, of England, presented a paper entitled "The Alloys of Aluminum and Zinc", the results of this research having previously been published in the tenth report of the Alloys Research Committee of the Institution of Mechanical Engineers. General L. Cubillo, of Spain, presented a paper entitled "Steel Founding in Spain" and briefly discussed the properties of molding sands for steel foundry practice.

REPRESENTATIVES OF THE FRENCH FOUNDRY INDUSTRY IN ATTENDANCE OF THE RECENT CONGRESS HELD AT PARIS

Appliances for Cast Steel". He described the various furnaces in use and ventured the opinion that the electric furnace has a bright future in the steel casting industry. He favored the arc type, as it is better adapted for small works, notwithstanding the fact that the induction furnace consumes less current and requires no electrodes.

L. Goujon presented a paper entitled "Foundry Apprenticeship and Instruction", in which he pointed out the necessity of properly training apprentices in foundry work. It would seem from his remarks that French foundrymen are confronted with the same difficulties that beset foundry operations in the United States,

The Fluidity of Iron

By W. J. Keep

Question.—What chemical composition or what melting conditions will insure the greatest fluidity of cast iron?

Answer.—The fluidity of molten iron is that property which insures the filling of every part of the mold. Iron when melted may be of such a chemical composition that a very small drop in temperature will cause it to be so thick that it cannot be poured out of the ladle. If a composition of this kind is required, the temperature in the ladle must be so high, and the facilities for handling must be such that the iron can be cast into the mold quickly, and the gates must be large enough to carry the iron into the mold before it becomes too thick to flow. Heavy gates of this kind must be broken off while the casting is hot. If the requirements are such as will permit of an increase in the silicon content, this will prevent the molten iron from thickening rapidly by a small decline in the temperature. Such iron will remain fluid longer than one containing a lower percentage of silicon and can be poured at a lower temperature, because the cooling effect of the mold itself will not thicken the phosphorus, the iron will remain fluid still longer, and such iron can be carried a further distance in the foundry than one comparatively low in phosphorus content. The iron need not be more fluid in one of the cases named than in the other, but its fluidity lasts longer in one instance than in the other, which, to the founder, means *increased fluidity*, because it permits him to fill every part of the molds. With low silicon and low phosphorus, fluidity must come from a high temperature and quick handling. With high silicon or phosphorus, the iron may not be any more fluid at the high temperature, but it remains fluid at lower temperatures. High sulphur causes melted iron to become thick quickly, causes gas holes and separation of the impurities after the iron has entered the mold, resulting in unsound castings. There are reasons for the use of low silicon and low phosphorus for dense, strong castings, but the silicon should be as high as possible without producing too coarse a grain.

Alloying Aluminum With the Rarer Metals*

Peculiar Behavior of This White Metal When Mixed With Other Metals—How the Physical Properties Are Affected

By C H Ivinson

IT IS generally admitted that pure commercial aluminum is entirely unsuited for most engineering purposes owing to the fact that it is too soft, has little mechanical strength, is rather difficult to cast, and does not lend itself to easy working. In general engineering work the alloys of aluminum are much more important than the pure metal; but the indiscriminate use of metals to form aluminum alloys has given the latter metal a bad reputation. Aluminum alloys with every known metallic element, accompanied by disengagement of heat, and is particularly active in combining with copper. Most of the alloys are chemical combinations of the metal rather than mechanical mixtures, the alloys with lead, antimony and mercury being exceptions, as these metals do not alloy very easily with aluminum.

Aluminum Alloys

The useful alloys of aluminum seem to fall in three groups:

Aluminum containing not more than 10 to 25 per cent of added metals.

Metals containing not more than 10 to 15 per cent of aluminum.

Alloys of rare metals with aluminum containing from 0.5 to 5 per cent of added metal.

In order to make aluminum harder, stronger and of better wearing properties, at the same time keeping its valuable lightness and beautiful color, it is alloyed with small percentages of such suitable metals as manganese, zinc, tin, copper, nickel, etc. It has been the writer's privilege to alloy aluminum with almost every metallic element, some of the resultant alloys being only curiosities, the cost of production making them of no commercial value.

The writer will first briefly deal with the commoner alloys, the best known being an alloy of copper and aluminum containing from 4 to 10 per cent of copper, and the aluminum-zinc alloys containing from 8 to 30 per cent zinc. Zinc is the cheapest known hardener of aluminum, and in quantities of 15 per cent combines to increase the rigidity and strength of the aluminum.

Tin Alloyed with Aluminum

Tin when alloyed alone with aluminum appears to develop brittleness, and alloys of 15 per cent of tin and aluminum have been known to entirely disintegrate in the course of a few days. Nickel added by itself to aluminum produces unstable alloys. An alloy of 4 per cent nickel has been known to disintegrate in a short time after being cast, but the introduction of a third element such as copper is an advantage. Phosphide of copper added in quantities of 1½ per cent to a zinc-aluminum alloy containing from 12½ to 15 per cent zinc gives fluidity to the molten metal. Phosphide of zinc containing 25 per cent phosphorus may be substituted in the proportion of 0.05 per cent. This is one of the best fluxing and cleansing agents for all aluminum alloys, and should be added to the molten alloy for a few minutes before pouring by wrapping in paper and plunging it to the bottom of the crucible by means of tongs and stirring briskly.

Magnesium-aluminum alloys containing 1 to 10 per cent magnesium are much improved by the addition of 5 per cent of zinc, as this addition imparts better wearing properties to the metal and aids in producing homogeneous castings. By the addition of 1 per cent of phosphide of copper, less oxidation of the metal takes place during the melting operations.

A few notes on the behavior of the alloys of copper, nickel, magnesium and zinc may be appreciated. All these alloys have good tensile strength when newly made, but in the course of time chemical and electrolytic actions render some of them very brittle, and in a good many cases lead to the entire disintegration of the alloy, especially if iron, sodium and silicon are in the metals as impurities. Aluminum is liable to take up silicon from the crucible, especially if overheated. It is important that these alloys should be melted without fluxes such as mixtures of sodium and potassium chloride. Zinc chloride acts on the crucible, thereby causing the aluminum to wet the sides of the crucible and dissolve out the silica which in the presence of moisture liberates silicon hydride, and in time, causes the entire disintegration of the alloy.

Too much stress cannot be laid upon the fact that the metal must be melted at as low a temperature as possible, namely, a temperature which will cause the metal to become fluid. Aluminum absorbs sulphur at a bright red heat, and the gas is liberated when the metal is poured into the molds, causing porous castings. Aluminum alloys should always be melted in crucibles having good, tight-fitting covers to prevent, to some extent, the absorption of sulphur from the fuel being used. Aluminum when heated to too high a temperature also absorbs nitrogen and hydro-carbons. The writer has found a small piece of potassium nitrate (an egg-spoonful to 100 pounds of metal) wrapped in filter paper, to be the best means of removing these occluded gases. A brisk reaction takes place which expels these gases. After the reaction has ceased the metal is poured at as low a temperature as possible, the pouring temperature affecting the tensile strength to a very marked degree.

Enemies of Aluminum Alloys

After numerous tests the writer is of the opinion that silicon and sulphur are two of the deadly enemies of aluminum alloys, especially when the metal is overheated.

It is always advisable when making an alloy of aluminum to make a concentrate of the metal which is to be alloyed with the aluminum, in other words, to first make a 20 or 25 per cent concentrate metal and add this in proper proportions to the molten aluminum.

During the last few years metal-

*Presented at the annual meeting of the British Foundrymen's Association.

lurgists have been experimenting with some of the rarer metals, and this part of the subject is most interesting. The writer has personally alloyed aluminum, as previously stated, with almost all the rarer metallic elements, such as cerium, neodymium, lanthanum, tantalum, zirconium and beryllium, and some of these alloys gave most remarkable results even in quantities of only 1 per cent and under. Cerium and beryllium are particularly interesting, 0.5 per cent of cerium exerting a most wonderful effect on aluminum, raising the tensile strength of the metal from 4.5 tons per square inch to 10.3 tons per square inch and giving an elongation of 8.5 per cent in 2 inches. This alloy was placed in sea-water and boiled for 60 hours; the sample was carefully weighed before and after the boiling process, and it was found that the metal was the same weight as before being experimented upon. One side of the metal was polished and after boiling it was found to be untarnished.

Another interesting alloy is one of beryllium or glucinum. An alloy of 2 per cent beryllium gave a tensile strength of 11.8 tons per square inch with an elongation of 10 per cent in 2 inches. It was of a beautiful silver white color, and could be hammered cold into leaf; it also withstood the action of sea water perfectly. This alloy was made by the reduction of beryllium fluoride.

Aluminum and Titanium

A good many experiments have been made during the past two or three years with alloys of manganese, titanium, chromium, molybdenum, tungsten, etc. They form a very interesting series of alloys, either when alloyed by themselves or in the presence of copper. Titanium and chromium alloys are both affected by sea water and ordinary atmospheric conditions. The former alloy, when polished in the presence of sea water, develops white spots on the metal which, when removed, show deep pit marks on the surface of the metal, and the same remarks apply to the alloys of chromium. Two methods have been employed to manufacture these two alloys: (1) The reduction of titanium and chromium oxide in a magnesite-lined crucible by means of powdered aluminum; (2) the reduction of the oxide of the metals by molten aluminum, using cryolite and potassium chloride as fluxes. The cryolite first is melted in a crucible and the oxide of the metal is dissolved in the molten cryolite to which the molten aluminum is added. These metals give rigid, hard alloys. The tensile strength of the one containing 2 per cent of metallic titanium was 10.4 tons per square inch, and the elongation 4.5 per cent in 2 inches. The alloy with chromium, containing 1.5 per cent metallic chromium, had a tensile strength of 9.34 tons per square inch, with an elongation of 2½ per cent in 2 inches. But the behavior of these alloys in resisting atmospheric conditions was far from satisfactory.

Tungsten has been recommended as being a suitable metal to alloy with aluminum to resist corrosion, but this has not proved satisfactory. An alloy containing 2 per cent copper and 0.5 per cent tungsten rapidly disintegrates under ordinary atmostpheric conditions. At least 100 different samples of this alloy were prepared in the varying proportions of 0.2 to 5 per cent pure tungsten alloyed by itself with the aluminum, and also in conjunction with nickel, manganese, copper, etc. The results of some of these were disappointing. The alloy of zinc and nickel containing 3 per cent nickel and 0.75 per cent zirconium gave extraordinary results as far as tensile strength was concerned. Its behavior in sea water was extraordinary; it was boiled for 72 hours in sea water and when tested, after the boiling process, its tensile strength was only 4 tons per square inch; its fracture was crystalline, and it was also very brittle.

Zirconium, 0.75 per cent, when alloyed with aluminum without the presence of nickel, gave the same tensile strength after the boiling process as before, namely, 9.3 tons per square inch. Molybdenum when alloyed with aluminum had the opposite result. An alloy was made containing 1.5 per cent molybdenum with aluminum which, after being boiled in salt water, gave a lower tensile strength than before the boiling; but when the molybdenum was alloyed with the aluminum in the presence of copper in the proportions of molybdenum 1.5 per cent and copper 1.5 per cent, the tensile strength of the metal after the boiling process was the same as originally. This makes the theoretical alloying of aluminum a fascinating subject, as it is almost impossible to theorize or to account for the peculiar behavior of these different elements when combined with this white metal. Within recent years several alloys have been put on the market for which sea water resisting properties and resistance to ordinary atmospheric influences are claimed. It is no doubt working on the above lines that such alloys have been made possible. The only drawback of the rare elements is their prohibitive cost, but it is to be hoped that chemists and metallurgists will continue experimenting to produce these rare elements at a commercial price.

There is no doubt that aluminum has obtained its bad reputation through the unscientific mixing of metals, and the compositions of some of the most successful alloys which withstand the action of sea water are rigidly guarded as secrets. Aluminum was exploited too greatly some years ago; it was recommended as being the cure-all for blow-holes in brass, iron and steel, also for promoting the fluidity of zinc, etc. In the writer's opinion aluminum should be added sparingly to brass, especially if the latter has to be remelted several times, as on each re-melting the aluminum oxidizes, rendering the brass porous and reducing greatly its mechanical strength. For steel aluminum is better added as a titanium-aluminum alloy and for the brass as a manganese-aluminum or titanium-aluminum alloy, as titanium and manganese seem to counteract the evil effects of the aluminum. The writer has used an alloy of 50 per cent titanium and 50 per cent aluminum with good results, whereas, when the aluminum was used alone, defective castings usually were produced.

Antimony in Brass Mixtures

By C Vickers

OWING to the continued high price of tin, considerable interest is manifested in the possibility of substituting antimony for this metal in brass mixtures. While the effect of antimony on copper is that of a hardener, it unfortunately produces brittleness also in a marked degree, and for this reason can only be used as a substitute for tin to a limited extent. In ordinary red metal in which strength is of no particular importance, antimony can sometimes be employed in place of a portion of the tin, and such mixtures have been in use for a considerable time. An alloy that may be cited as an example follows:

Copper, 88 per cent; zinc, 6 per cent; tin, 2.5 per cent; lead, 2 per cent, and antimony, 1.5 per cent.

This alloy is a fairly good, ordinary

red brass, but much of the ductility of the original alloy, which contained 4 per cent tin, has been sacrificed to cheapness, therefore, it cannot be used for many purposes for which the original alloy would have been satisfactory.

Another mixture that was tried was a cheap bearing alloy of the following composition: Copper, 76.5 per cent; lead, 12 per cent; zinc, 8 per cent, and antimony, 3.5 per cent. Undoubtedly there are some purposes for which such an alloy can be employed, but it will not stand rough usage.

A hard, sonorous, copper-colored alloy consists of the following: Copper, 94 per cent; silicon-copper, 1.5 per cent, and antimony, 4.5 per cent. This alloy has been used for trolley wheels.

To ascertain the effect of large proportions of antimony on copper, several alloys were tried and may be given here as a matter of curiosity, and not because they possess any practical value.

The first alloy tested consisted of 4 parts copper to 1 part of antimony. This alloy was characterized by closeness of grain, its crystalline structure and brittleness. It was white and could be given a high polish.

Another alloy consisted of 8 parts copper to 1 part antimony. This alloy possessed a little elongation, a test bar ½ inch in section and 12 inches between supports, deflected 1¼ inches before breaking. In another series of alloys, zinc was introduced by first alloying it with antimony in the proportion of 50 per cent zinc and 50 per cent antimony. This alloy was white and exceedingly brittle; 12 per cent of this alloy was added to copper, producing an alloy that was cold-short, rather hard, of a good bronze color internally, but curiously, the castings, externally, presented the appearance of having been tinned. A test bar ½ inch in diameter, 12 inches between supports, deflected 2 inches without breaking, but cracked when straightened. When the above results are contrasted with the well-known effects of tin when used in the same proportions as the antimony, it will be noted that the two metals, antimony and tin, are entirely dissimilar in their effects on copper and its alloys.

Antimony in Bronze

When antimony is used in bronze (copper and tin alloys) in place of a portion of the tin, the effect is to make the alloy no better than a common brass. In one set of experiments conducted by the writer, an alloy of 88 per cent copper; 10 per cent tin, and 2 per cent zinc, was treated with 1 per cent of a deoxidizing alloy, with the following results:

Tensile strength, pounds per square inch	44,100
Elastic limit, pounds per square inch	24,000
Elongation in 2 inches, per cent.	16
Reduction of area, per cent	15

In the next test the alloy was altered to the following: Copper, 88 per cent; tin, 8 per cent; antimony, 2 per cent; zinc, 2 per cent, and deoxidizing alloy, 1 pound.

The change involved the substitution of 2 per cent of antimony for 2 per cent of tin, and the physical properties were unfavorably affected, as the following results indicate:

Tensile strength, pounds per square inch	32,700
Elastic limit, pounds per square inch	24,100
Elongation in 2 inches, per cent.	6
Reduction of area, per cent	5.7

The substitution of only 2 per cent of antimony for the same amount of tin, therefore, reduced the tensile strength of the alloy 11,400 pounds, reduced the elongation almost two-thirds, but as a compensation slightly increased the elastic elimit. By this change this high grade and expensive bronze was ruined, because, for all practical purposes, it was rendered no better than a cheap alloy.

Other instances might be cited, but the ones given will show what can be expected from the substitution of antimony for tin in brass mixtures. In the case of the 88-10-2 alloy given, the metal would have been much better had 2 per cent of zinc been substituted for the 2 per cent of tin it was desired to save and if the antimony had been omitted entirely from this mixture.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Strong Aluminum Alloy

We received an order for automobile side frames which are to be cast in aluminum. We would like to know how we can increase the strength of the metal, as pure aluminum will not answer the purpose for which these castings are intended. Whatever addition is to be made, however, should not greatly increase the specific gravity of the mixture.

The aluminum should be hardened by the addition of copper in amounts varying from 6 to 8 per cent of the alloy. The copper should be added in the form of a hardener, consisting of copper, 50 per cent, and aluminum, 50 per cent. To make the hardener melt a given weight of copper and add gradually the same amount of aluminum. After the first addition of aluminum is made to the copper, the latter will become quite hot and as it is desirable to keep the temperature as low as possible, the copper should be no more than thoroughly liquid when the addition of aluminum is commenced. The final alloy is made by melting together 86 pounds of aluminum and 14 pounds of the hardener. Place the hardener in the bottom of the crucible upon which the ingot aluminum is charged. After melting, stir thoroughly to incorporate the hardener in the bottom of the crucible, and then charge the balance of the aluminum. Do not permit the alloy to attain a temperature in excess of 1,200 Fahr. This alloy is known as No. 12 and is used universally for automobile castings.

Yellow Brass Difficulties

We are manufacturing castings from a mixture containing copper, 62 per cent; zinc, 32 per cent, and lead, 3 per cent. A small amount of aluminum is used as a flux. We experience considerable trouble from blow-holes and we would like to have you advise us whether the mixture we are using is satisfactory and how to overcome our present difficulties.

The mixture which you are using is commonly employed for a cheap grade of yellow brass castings and with the addition of aluminum you should obtain good results. We suggest strict supervision over your melting methods for a few days to determine whether or not this is the source of your trouble. The surface of the copper should be covered with charcoal

and aluminum should be added to the copper when the latter is melted. It then will act as a deoxidizer. After the addition of aluminum has been made the metal should be stirred thoroughly, after which the zinc is added. The zinc should be warmed before placing it in the crucible. The molding sand should be sufficiently open to permit the free escape of the gases generated by the molten metal, and this is especially important in the production of yellow brass castings. A close sand containing a high percentage of clay will result in a large number of defective castings.

Brass Tubing Alloy

We received an order for bracket fixtures which, when polished, are to be the same color as brass tubing. We would be pleased to have a mixture for this purpose.

The standard composition of brass tubing is copper 75 per cent and zinc 25 per cent. As this alloy is soft, it is advisable to strengthen it for casting purposes by the addition of tin and to improve its machining qualities a small amount of lead usually is incorporated. An excellent alloy for your purpose follows: Copper, 70 pounds; zinc, 25 pounds; tin, 3 pounds, and lead 2 pounds.

Pattern Metal Mixtures

Kindly furnish us with a good, non-shrinking pattern metal mixture.

A non-shrinking metal does not exist. Bismuth, which occasionally is used to reduce the shrinkage of white metal mixtures, contracts in cooling, from 0.03 to 0.048 inch per foot and the shrinkage of antimony is slightly greater than this, being about 0.052 inch per foot. Both antimony and bismuth expand at the moment of solidification, but this expansion later is followed by contraction which, while not as great in the case of most other metals, more than offsets the previous expansion and renders it impossible to obtain an absolutely non-shrinking pattern alloy. In making pattern alloys in which the contraction should be reduced as low as possible, the use of bismuth or antimony is advisable, because of their slight shrinkage. However, these metals only can be used as hardeners of other metals, such as tin or lead which constitute the base of the alloy.

Typical pattern metal mixtures follow:

Lead, 87 per cent, and antimony, 13 per cent.

Lead, 80 per cent; antimony, 10 per cent, and tin, 10 per cent.

Lead, 80 per cent; antimony, 15 per cent, and bismuth, 5 per cent.

Blast Furnace Bosh Plates

We received an order for bronze bosh plates for blast furnaces which are to withstand a water pressure of from 60 to 100 pounds per square inch. These plates are ½ inch thick and the ribs ¼ inch thick. The plates are approximately 20 inches long, 15 inches wide and 3½ inches in section. When melting, the metal is kept well covered with charcoal and 2 per cent of silicon-copper is added before it is removed from the furnace. We also have added 3 per cent of zinc to the metal after it is taken from the furnace. We would like to have you suggest a better method, if possible.

The term *bronze* is improperly applied to these bosh plates, as it is the customary practice to make these castings of copper. The only additions which you state are made to the copper are zinc and silicon, which frequently are employed as deoxidizers of this metal. The practice of using both of these deoxidizers is open to criticism, as either one or the other added in the quantities given should produce solid copper castings, provided care is exercised in melting the copper. Usually the addition of 1 per cent of silicon-copper is sufficient for the production of sound copper castings, although as small an amount as possible should be used, owing to the fact that the effect of silicon is similar to that of aluminum, although in a lesser degree. When used in excessive amounts, silicon will produce dross in copper. We would suggest that a trial be made with 1 per cent of silicon-copper and that the zinc be left out of the mixture. If any difficulty is experienced from leakage under water pressure when the silicon is employed, try zinc alone or in conjunction with 1 per cent of phosphor-tin.

Aluminum Bronze

We have been endeavoring to make aluminum bronze, using 90 pounds of copper and 10 pounds of aluminum. The copper was in the form of scrap trolley wire and ingot aluminum was employed. The results, however, were not satisfactory. Can you suggest a better mixture and recommend a method of melting?

The alloy referred to is known as a 10 per cent aluminum bronze. This mixture is difficult to make and cast successfully, because if the proportions of copper and aluminum are not carefully weighed, the alloy may be brittle. In addition, it is a peculiarity of this mixture that the castings are liable to be drossy and are liable to contain blow-holes. We would suggest that the mixture be changed to the following:

Copper, 91 per cent; aluminum, 9 per cent, and 30 per cent manganese-copper, 1 per cent.

Add the aluminum in the form of a hardener consisting of equal parts of aluminum and copper. This hardener is melted and cast into ingots and owing to its brittleness, it can be broken into small pieces to permit of adding it conveniently to the molten copper. When making the final alloy, this hardener should be added to the mixture given, in the proportion of 18 pounds to 82 pounds of copper. The copper first should be melted and when thoroughly liquid, the manganese-copper is added, stirring the mixture well in the meantime. The hardener then is added as fast as the copper will dissolve it. The manganese-copper will aid in preventing blow-holes, but it is not a specific for this difficulty in the case of aluminum bronze.

Bushing Mixture

One of our customers insists that we cast the bushings which we are making for him from the following mixture: Copper, 80 per cent; lead, 10 per cent; zinc, 8 per cent, and tin, 2 per cent. The castings invariably are honeycombed and the holes in the metal are spotted with crystals, which we presume is lead. It is our opinion that the percentage of lead is entirely too high.

The formula given constitutes a cheap red brass, and while it is not adapted for bushings, nevertheless no difficulty should be experienced in casting this alloy. If the percentage of lead were too high it would not be held in solution, but would settle to the bottom of the casting. Also, it might be extended in the form of beads from the casting if it is removed from the sand in a hot condition. The lead will not cause honeycombing, as this condition is due to the absorption of oxygen. The addition of ¼ per cent of 30 per cent manganese-copper will probably remedy porosity. The following alloy will prove more satisfactory for these castings: Copper, 78 per cent; lead, 15 per cent, and tin, 7 per cent.

Elianite is a new alloy prepared in the electric furnace, which is particularly resistant to acids. It is not attacked by chlorine or bromine in a free condition, by hydrochloric, sulphuric or nitric acids, or by *aqua regia* made up of three parts of hydrochloric acid to one of nitric acid. The specific gravity of elianite is 6.8 and its melting point is 1,250 degrees Cent. It is a good conductor of heat and its resistance to corrosion is 1,000 times that of cast iron.

Improvements at the Plant of the Falk Company

Description of the New Open-Hearth and Annealing Furnaces, Gas Producers and Coal-Handling Plant in the Steel Casting Department

IN TWO years, between 1910 and 1912, the number of foundries in Milwaukee increased from 62 to 68, or nearly 10 per cent. Although this shows the rapid growth of the foundry industry in the Wisconsin metropolis, it does not tell the whole story, for during the time new shops were being built, the existing plants found it necessary to materially increase their capacity. The Falk Co., which operates one of the largest steel casting plants in the northwest, is in the latter class. This corporation is constantly adding to its facilities and has recently completed improvements that are specially noteworthy because they involve not only additional output, but a change in metallurgical fuel from oil to producer gas. The installation of gas-making equipment has been made necessary by the growing scarcity and constantly advancing prices of fuel oil.

The improvements comprise a six-producer gas plant with the necessary coal-handling apparatus, a 25-ton stationary, gas-burning open-hearth furnace and two gas-fired annealing furnaces.

Melting Capacity Increased

The present melting equipment of The Falk Co. includes 15 and 18-ton Wellman tilting open-hearth furnaces, together with a small converter. The new furnace will increase the steel-making capacity by slightly over 50 per cent, making it possible for the company to pour practically 220 tons of melted metal per day. Important extensions also have been made to the molding floors so that now the main molding room is 1,000 feet long and 50 feet wide with a lean-to, 500 x 25 feet, and a secondary molding bay, 550 x 80 feet. This space not being sufficient, a passageway between the foundry and machine shop, 40 x 300 feet, is now being converted into a molding room. The core room at present is 42 x 150 feet. Arthur L. Stevens Co., contracting engineer, Chicago, designed and supervised the erection of the gas producers, open-hearth furnace and annealing equipment.

The gas producer plant, Figs. 1, 2 and 3, is located north of and parallel to the open-hearth charging platform. The producer house has an overall length of 118 feet and a width, including gas main foundations, of 48 feet, 6 inches. Six 10-foot producers built by the Morgan Construction Co., Worcester, Mass., have been installed and space has been left for two additional units which may be

FIG. 1—MORGAN GAS PRODUCERS WITH GEORGE MECHANICAL FEED

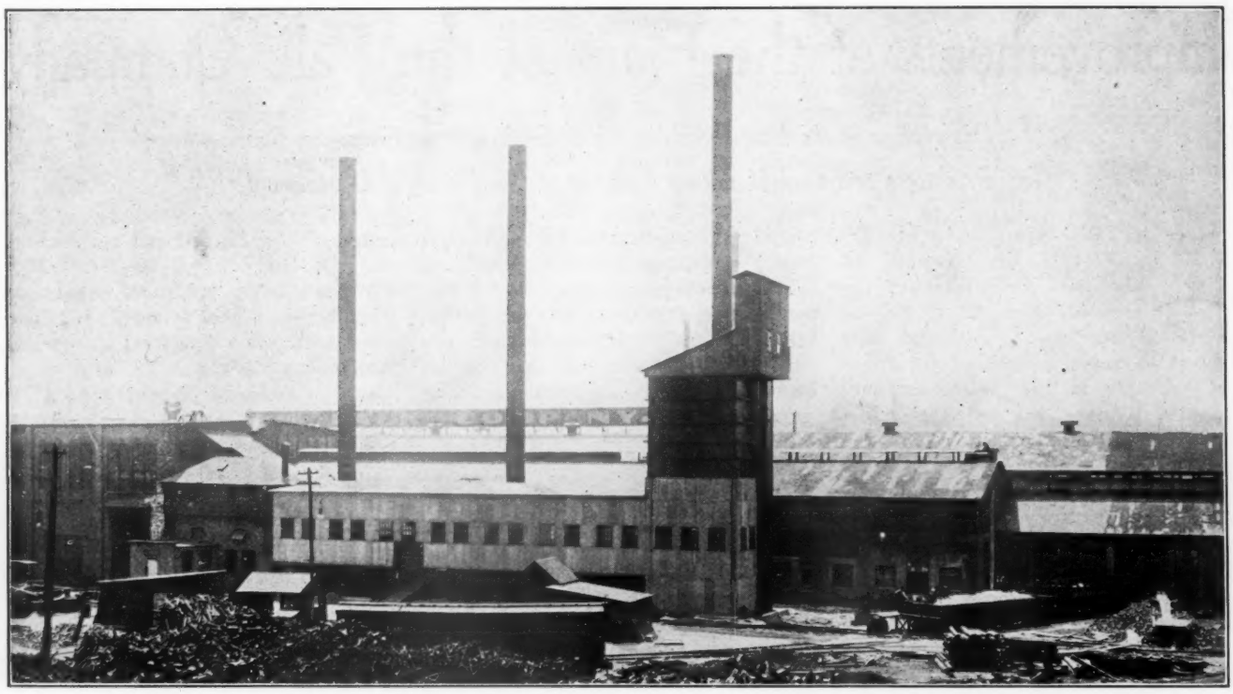


FIG. 2—GAS PRODUCER HOUSE WITH COAL STORAGE BIN

added to the equipment without extending the producer house or increasing the coal-handling facilities. The general layout of the gas producers and coal-handling plant is shown in Fig. 3.

The foundation of the producer house is a concrete monolith, approximately 125 feet long and 30 feet wide, with an average thickness of 4 feet. It is strengthened in the vicinity of the coal hopper as indicated in Fig. 3.

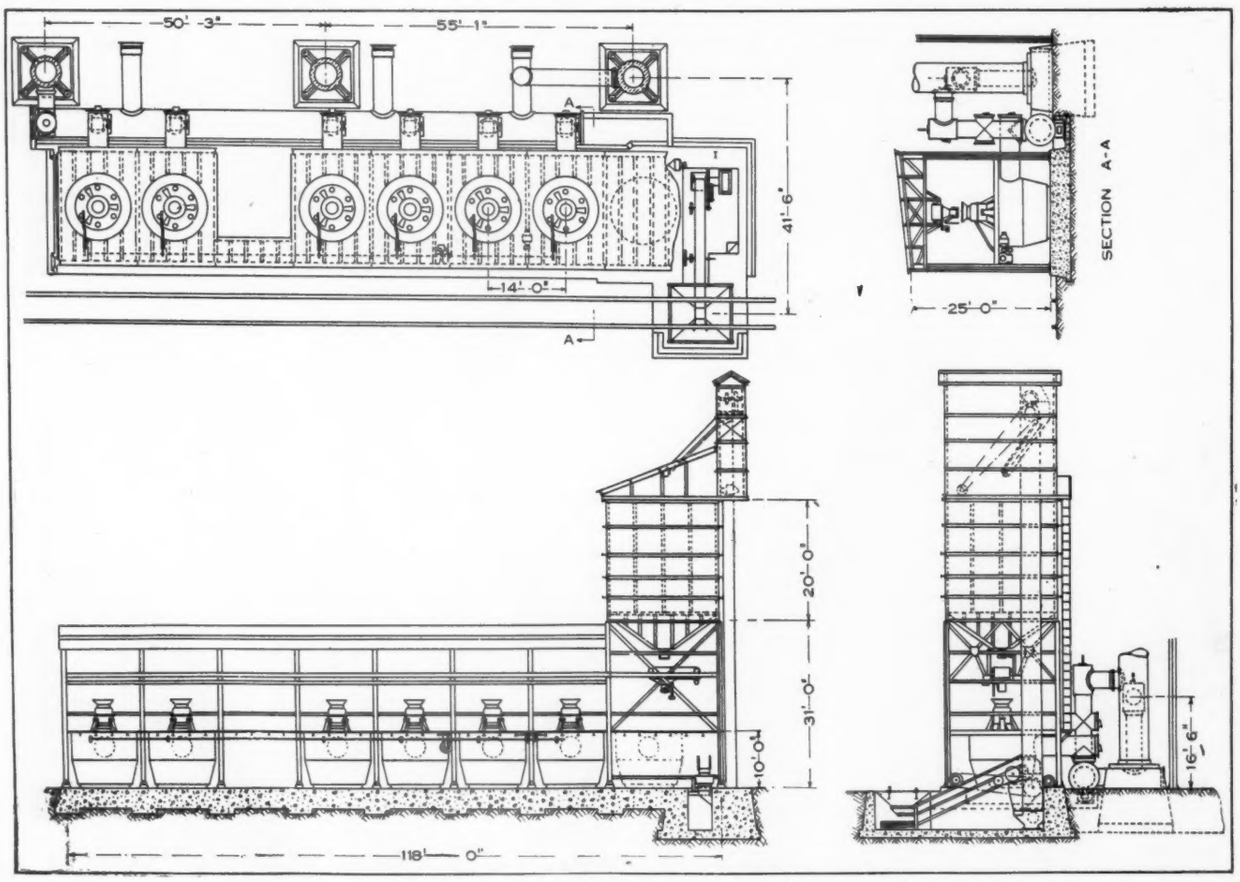


FIG. 3—GENERAL ARRANGEMENT OF GAS PRODUCER PLANT

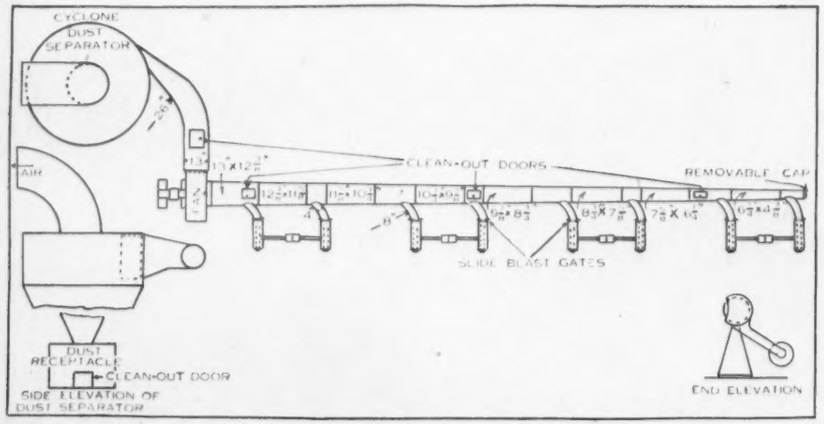
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form

SPECIFICATIONS FOR EXHAUST SYSTEMS.

(*Continued from Data Sheet No. 142*)

The accompanying illustration shows an exhaust system for eight 14-inch emery wheels, designed in conformity with these specifications. For eight 14-inch buffing wheels, the branch pipes would have to be not less than 4½ inches in diameter and the increased size of the main suction duct and the fan would have to be determined as provided by the specifications. The main discharge



PLAN AND ELEVATIONS OF EXHAUST SYSTEM FOR EIGHT 14-INCH EMERY WHEELS

pipe also would have to be larger and the cyclone separator should be considerably larger for buffing wheels than for emery wheels. The dimensions on the tapered sections indicate diameters at large and small ends, respectively. The area of the main suction duct at the small end of each tapered section equals the sum of the areas of the preceding branch pipes, plus 20 per cent.

WEIGHT OF CAST IRON IN POUNDS

From 1 cubic inch to 1,000 cubic inches

	0	100	200	300	400	500	600	700	800	900
1	.26	26.26	52.26	78.26	104.26	130.26	156.26	182.26	208.26	234.26
2	.52	26.52	52.52	78.52	104.52	130.52	156.52	182.52	208.52	234.52
3	.78	26.78	52.78	78.78	104.78	130.78	156.78	182.78	208.78	234.78
4	1.04	27.04	53.04	79.04	105.04	131.04	157.04	183.04	209.04	235.04
5	1.30	27.30	53.30	79.30	105.30	131.30	157.30	183.30	209.30	235.30
6	1.56	27.56	53.56	79.56	105.56	131.56	157.56	183.56	209.56	235.56
7	1.82	27.82	53.82	79.82	105.82	131.82	157.82	183.82	209.82	235.82
8	2.08	28.08	54.08	80.08	106.08	132.08	158.08	184.08	210.08	236.08
9	2.34	28.34	54.34	80.34	106.34	132.34	158.34	184.34	210.34	236.34
10	2.60	28.60	54.60	80.60	106.60	132.60	158.60	184.60	210.60	236.60
11	2.86	28.86	54.86	80.86	106.86	132.86	158.86	184.86	210.86	236.86
12	3.12	29.12	55.12	81.12	107.12	133.12	159.12	185.12	211.12	237.12
13	3.38	29.38	55.38	81.38	107.38	133.38	159.38	185.38	211.38	237.38
14	3.64	29.64	55.64	81.64	107.64	133.64	159.64	185.64	211.64	237.64
15	3.90	29.90	55.90	81.90	107.90	133.90	159.90	185.90	211.90	237.90
16	4.16	30.16	56.16	82.16	108.16	134.16	160.16	186.16	212.16	238.16
17	4.42	30.42	56.42	82.42	108.42	134.42	160.42	186.42	212.42	238.42
18	4.68	30.68	56.68	82.68	108.68	134.68	160.68	186.68	212.68	238.68
19	4.94	30.94	56.94	82.94	108.94	134.94	160.94	186.94	212.94	238.94
20	5.20	31.20	57.20	83.20	109.20	135.20	161.20	187.20	213.20	239.20
21	5.46	31.46	57.46	83.46	109.46	135.46	161.46	187.46	213.46	239.46
22	5.72	31.72	57.72	83.72	109.72	135.72	161.72	187.72	213.72	239.72
23	5.98	31.98	57.98	83.98	109.98	135.98	161.98	187.98	213.98	239.98
24	6.24	32.24	58.24	84.24	110.24	136.24	162.24	188.24	214.24	240.24
25	6.50	32.50	58.50	84.50	110.50	136.50	162.50	188.50	214.50	240.50
26	6.76	32.76	58.76	84.76	110.76	136.76	162.76	188.76	214.76	240.76
27	7.02	33.02	59.02	85.02	111.02	137.02	163.02	189.02	215.02	241.02
28	7.28	33.28	59.28	85.28	111.28	137.28	163.28	189.28	215.28	241.28
29	7.54	33.54	59.54	85.54	111.54	137.54	163.54	189.54	215.54	241.54
30	7.80	33.80	59.80	85.80	111.80	137.80	163.80	189.80	215.80	241.80
31	8.06	34.06	60.06	86.06	112.06	138.06	164.06	190.06	216.06	242.06
32	8.32	34.32	60.32	86.32	112.32	138.32	164.32	190.32	216.32	242.32
33	8.58	34.58	60.58	86.58	112.58	138.58	164.58	190.58	216.58	242.58
34	8.84	34.84	60.84	86.84	112.84	138.84	164.84	190.84	216.84	242.84
35	9.10	35.10	61.10	87.10	113.10	139.10	165.10	191.10	217.10	243.10
36	9.36	35.36	61.36	87.36	113.36	139.36	165.36	191.36	217.36	243.36
37	9.62	35.62	61.62	87.62	113.62	139.62	165.62	191.62	217.62	243.62
38	9.88	35.88	61.88	87.88	113.88	139.88	165.88	191.88	217.88	243.88
39	10.14	36.14	62.14	88.14	114.14	140.14	166.14	192.14	218.14	244.14
40	10.40	36.40	62.40	88.40	114.40	140.40	166.40	192.40	218.40	244.40
41	10.66	36.66	62.66	88.66	114.66	140.66	166.66	192.66	218.66	244.66
42	10.92	36.92	62.92	88.92	114.92	140.92	166.92	192.92	218.92	244.92
43	11.18	37.18	63.18	89.18	115.18	141.18	167.18	193.18	219.18	245.18
44	11.44	37.44	63.44	89.44	115.44	141.44	167.44	193.44	219.44	245.44
45	11.70	37.70	63.70	89.70	115.70	141.70	167.70	193.70	219.70	245.70
46	11.96	37.96	63.96	89.96	115.96	141.96	167.96	193.96	219.96	245.96
47	12.22	38.22	64.22	90.22	116.22	142.22	168.22	194.22	220.22	246.22
48	12.48	38.48	64.48	90.48	116.48	142.48	168.48	194.48	220.48	246.48
49	12.74	38.74	64.74	90.74	116.74	142.74	168.74	194.74	220.74	246.74
50	13.00	39.00	65.00	91.00	117.00	143.00	169.00	195.00	221.00	247.00
51	13.26	39.26	65.26	91.26	117.26	143.26	169.26	195.26	221.26	247.26
52	13.52	39.52	65.52	91.52	117.52	143.52	169.52	195.52	221.52	247.52
53	13.78	39.78	65.78	91.78	117.78	143.78	169.78	195.78	221.78	247.78
54	14.04	40.04	66.04	92.04	118.04	144.04	170.04	196.04	222.04	248.04
55	14.30	40.30	66.30	92.30	118.30	144.30	170.30	196.30	222.30	248.30
56	14.56	40.56	66.56	92.56	118.56	144.56	170.56	196.56	222.56	248.56
57	14.82	40.82	66.82	92.82	118.82	144.82	170.82	196.82	222.82	248.82
58	15.08	41.08	67.08	93.08	119.08	145.08	171.08	197.08	223.08	249.08
59	15.34	41.34	67.34	93.34	119.34	145.34	171.34	197.34	223.34	249.34
60	15.60	41.60	67.60	93.60	119.60	145.60	171.60	197.60	223.60	249.60
61	15.86	41.86	67.86	93.86	119.86	145.86	171.86	197.86	223.86	249.86
62	16.12	42.12	68.12	94.12	120.12	146.12	172.12	198.12	224.12	250.12
63	16.38	42.38	68.38	94.38	120.38	146.38	172.38	198.38	224.38	250.38
64	16.64	42.64	68.64	94.64	120.64	146.64	172.64	198.64	224.64	250.64
65	16.90	42.90	68.90	94.90	120.90	146.90	172.90	198.90	224.90	250.90
66	17.16	43.16	69.16	95.16	121.16	147.16	173.16	199.16	225.16	251.16
67	17.42	43.42	69.42	95.42	121.42	147.42	173.42	199.42	225.42	251.42
68	17.68	43.68	69.68	95.68	121.68	147.68	173.68	199.68	225.68	251.68
69	17.94	43.94	69.94	95.94	121.94	147.94	173.94	199.94	225.94	251.94
70	18.20	44.20	70.20	96.20	122.20	148.20	174.20	200.20	226.20	252.20
71	18.46	44.46	70.46	96.46	122.46	148.46	174.46	200.46	226.46	252.46
72	18.72	44.72	70.72	96.72	122.72	148.72	174.72	200.72	226.72	252.72
73	18.98	44.98	70.98	96.98	122.98	148.98	174.98	200.98	226.98	252.98
74	19.24	45.24	71.24	97.24	123.24	149.24	175.24	201.24	227.24	253.24
75	19.50	45.50	71.50	97.50	123.50	149.50	175.50	201.50	227.50	253.50
76	19.76	45.76	71.76	97.76	123.76	149.76	175.76	201.76	227.76	253.76
77	20.02	46.02	72.02	98.02	124.02	150.02	176.02	202.02	228.02	254.02
78	20.28	46.28	72.28	98.28	124.28	150.28	176.28	202.28	228.28	254.28
79	20.54	46.54	72.54	98.54	124.54	150.54	176.54	202.54	228.54	254.54
80	20.80	46.80	72.80	98.80	124.80	150.80	176.80	202.80	228.80	254.80
81	21.06	47.06	73.06	99.06	125.06	151.06	177.06	203.06	229.06	255.06
82	21.32	47.32	73.32	99.32	125.32	151.32	177.32	203.32	229.32	255.32
83	21.58	47.58	73.58	99.58	125.58	151.58	177.58	203.58	229.58	255.58
84	21.84	47.84	73.84	99.84	125.84	151.84	177.84	203.84	229.84	255.84
85	22.10	48.10	74.10	100.10	126.10	152.10	178.10	204.10	230.10	256.10
86	22.36	48.36	74.36	100.36	126.36	152.36	178.36	204.36	230.36	256.36
87	22.62	48.62	74.62	100.62	126.62	152.62	178.62	204.62	230.62	256.62
88	22.88	48.88	74.88	100.88	126.88	152.88	178.88	204.88	230.88	256.88
89	23.14	49.14	75.14	101.14	127.14	153.14	179.14	205.14	231.14	257.14
90	23.40	49.40	75.40	101.40	127.40	153.40	179.40	205.40	231.40	257.40
91	23.66	49.66	75.66	101.66	127.66	153.66	179.66	205.66	231.66	257.66
92	23.92	49.92	75.92	101.92	127.92	153.92	179.92	205.92	231.92	257.92
93	24.18	50.18	76.18	102.18	128.18	154.18	180.18	206.18	232.18	258.18
94	24.44	50.44	76.44	102.44	128.44	154.44	180.44	206.44	232.44	258.44
95	24.70	50.70	76.70	102.70	128.70	154.70	180.70	206.70	232.70	258.70
96	24.96	50.96	76.96	102.96	128.96	154.96	180.96	206.96	232.96	258.96
97	25.22	51.22	77.22	103.22	129.22	155.22	181.22	207.22	233.22	259.22
98	25.48	51.48	77.48	103.48	129.48	155.48	181.48	207.48	233.48	259.48
99	25.74	51.74	77.74	103.74	129.74	155.74	181.74	207.74	233.74	259.74
100	26.00	52.00	78.00	104.00	130.00	156.00	182.00	208.00	234.00	260.00

FIG. 4—CHARGING SIDE OF 25-TON OPEN-HEARTH FURNACE

A track extends along the front of the gas house on which hopper cars carrying the coal are received. The fuel is discharged from the cars into a concrete track bin, 11 feet long and 10 feet wide, located at one end of the plant under the coal storage house. The coal drops from the track hopper onto an 18-inch apron feeder which in turn discharges it into a crusher. After passing through the latter, it runs into the boot of a bucket elevator which conveys it to the roof of the coal-handling plant and discharges it into the storage bin. The bin has a capacity of 250 tons of crushed coal and the elevating and crushing machinery has a capaci-

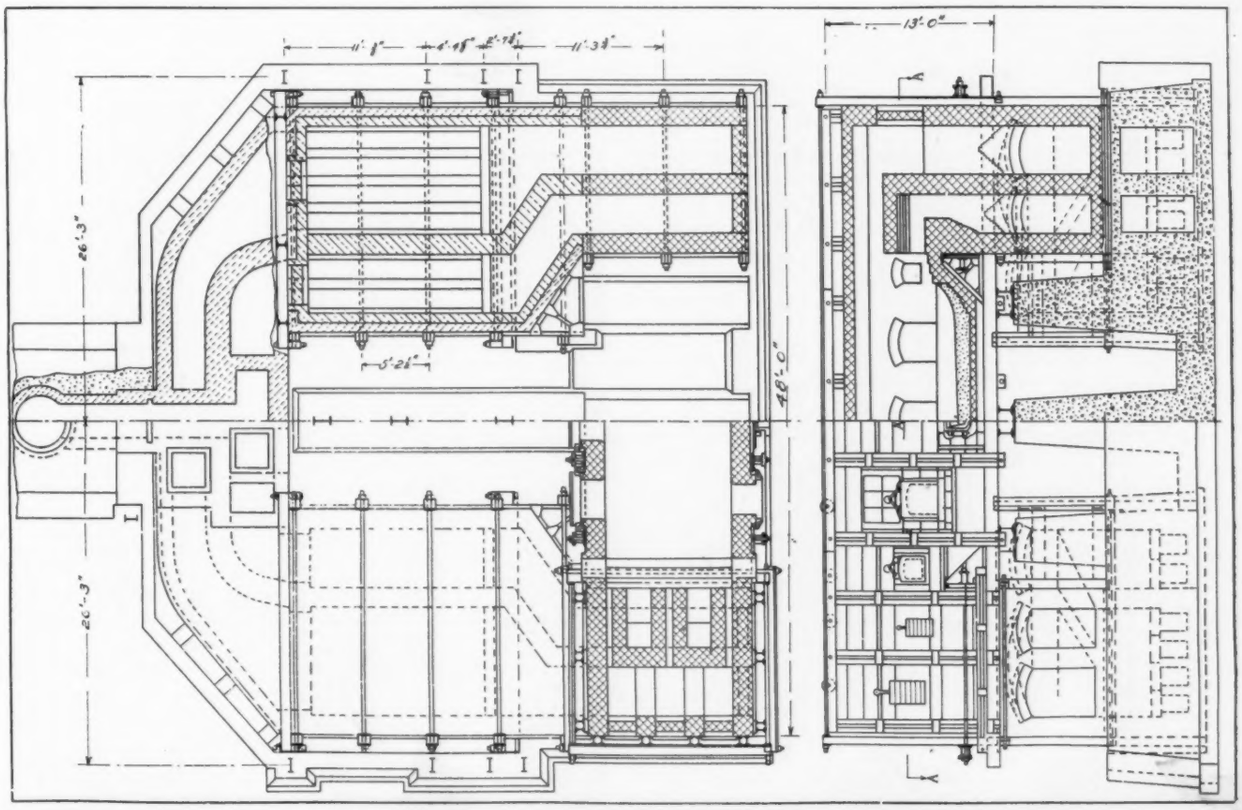


FIG. 5—PLAN AND SECTIONS OF OPEN-HEARTH FURNACE

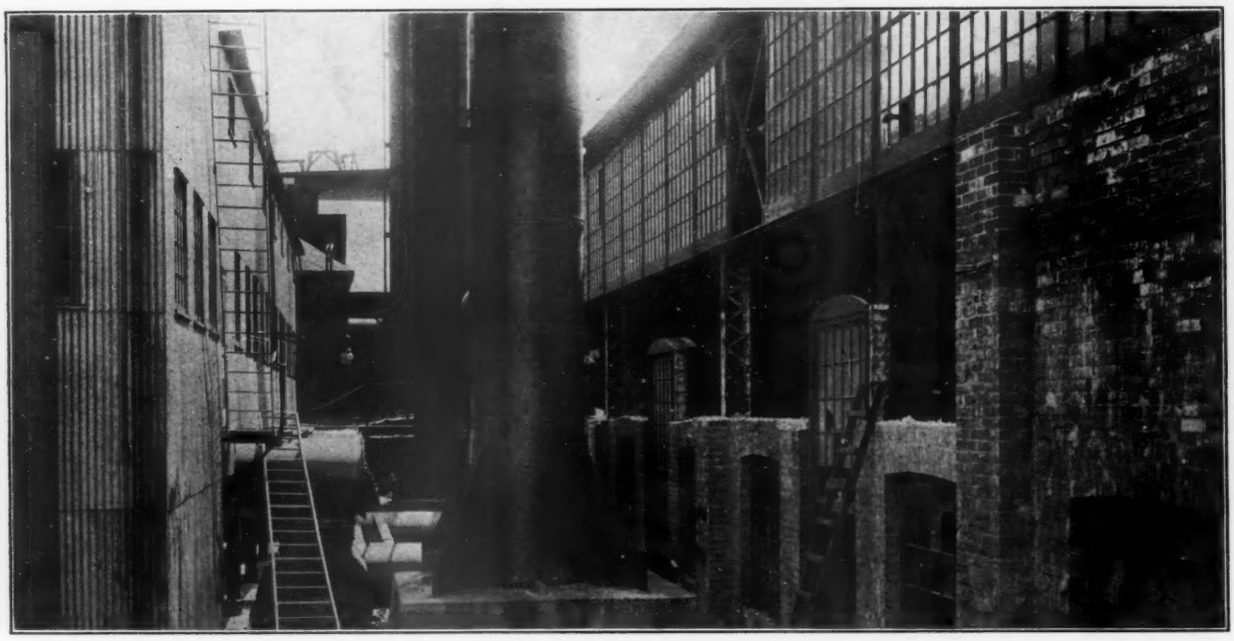


FIG. 6—STEEL STACKS AND GAS MAINS

ty of 20 tons per hour. The elevator, which has a lift of 75 feet, is driven by a 10 horsepower motor running at 750 revolutions per minute. A 10½-inch pulley on the motor shaft carries a 3-inch belt which is connected to the driving pully of the elevator. The apron feeder and the crusher are operated by a 15-horsepower motor running at 700 revolutions per minute.

From a gate in the bottom of the storage bin, the coal is discharged into a steel, electrically-driven larry car which runs on a track over the producers, as indicated in Fig. 1. The latter transfers the fuel directly into the feed hoppers of the producers. The coal-handling apparatus was furnished by the Link Belt Co., Chicago, and the electrical equipment by the Milwaukee Electric Co., Milwaukee. The gas producers have a rated coal consumption of 10 tons in 24 hours. With the entire battery in operation, the capacity of the coal storage bin is sufficient to keep the plant running for slightly over four days, while the coal-handling facilities are sufficient to elevate a full day's supply of fuel in three hours.

The producers are hand-poked, but are provided with a George mechanical feed. This consists of a rotary hopper operated by a pawl and ratchet gear connected to a line shaft, as shown in Fig. 1. The producers are set on 14-foot centers and the charging floor of the producer house is 10 feet above the top of the foundation. The line shaft for the mechanical feed is driven by a 10-horsepower

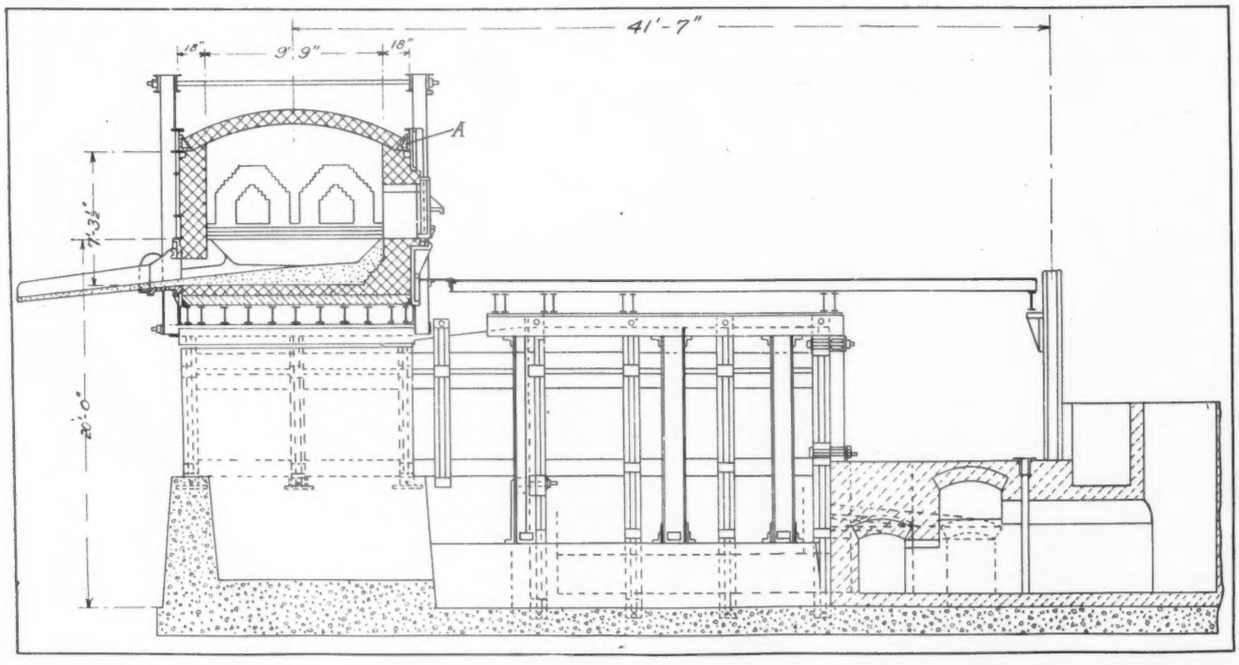


FIG. 7—SECTION OF OPEN-HEARTH FURNACE, SHOWING ARRANGEMENT OF GAS PORTS

motor suspended underneath the charging floor.

The gas connections from the producers are shown clearly in Figs. 3 and 6. The manifold behind the producer house is 5 feet in diameter inside and the mains leading to the furnaces are 3 feet, 6 inches. The three self-sustaining steel stacks are each 5 feet in diameter and 125 feet in height.

As shown in Fig. 2, one of the spaces which will eventually be utilized for an additional gas producer is now occupied by an incline on which the scrap charges are hauled up to the furnace platform. When the complete equipment of eight producers is installed, this incline will be removed and the scrap yard will be shifted around to a point west of the present foundry buildings.

The new 25-ton, gas-fired, open-hearth furnace is located immediately west of the old tilting furnaces and is so arranged that the same charging machine may be utilized for the entire battery. It was built from special designs prepared by Arthur L. Stevens Co., Chicago. The new furnace has an acid lining. Its overall dimensions, including regenerators, are situated behind the furnace under the charging platform in such a position that they are readily accessible.

Considerable care was necessary in preparing the foundations for the furnaces owing to the fact that water is encountered a few feet beneath the surface of the ground. In order to avoid settlement it was necessary to drive about 200 piles on which a dense, waterproof concrete slab or monolith has been laid. The latter varies from 1½ to 8½ feet in thickness, and it is carried up around the sides of the regenerators a sufficient height to prevent any trouble from seepage. The furnace itself is separate from the foundation and may contract and expand independently.

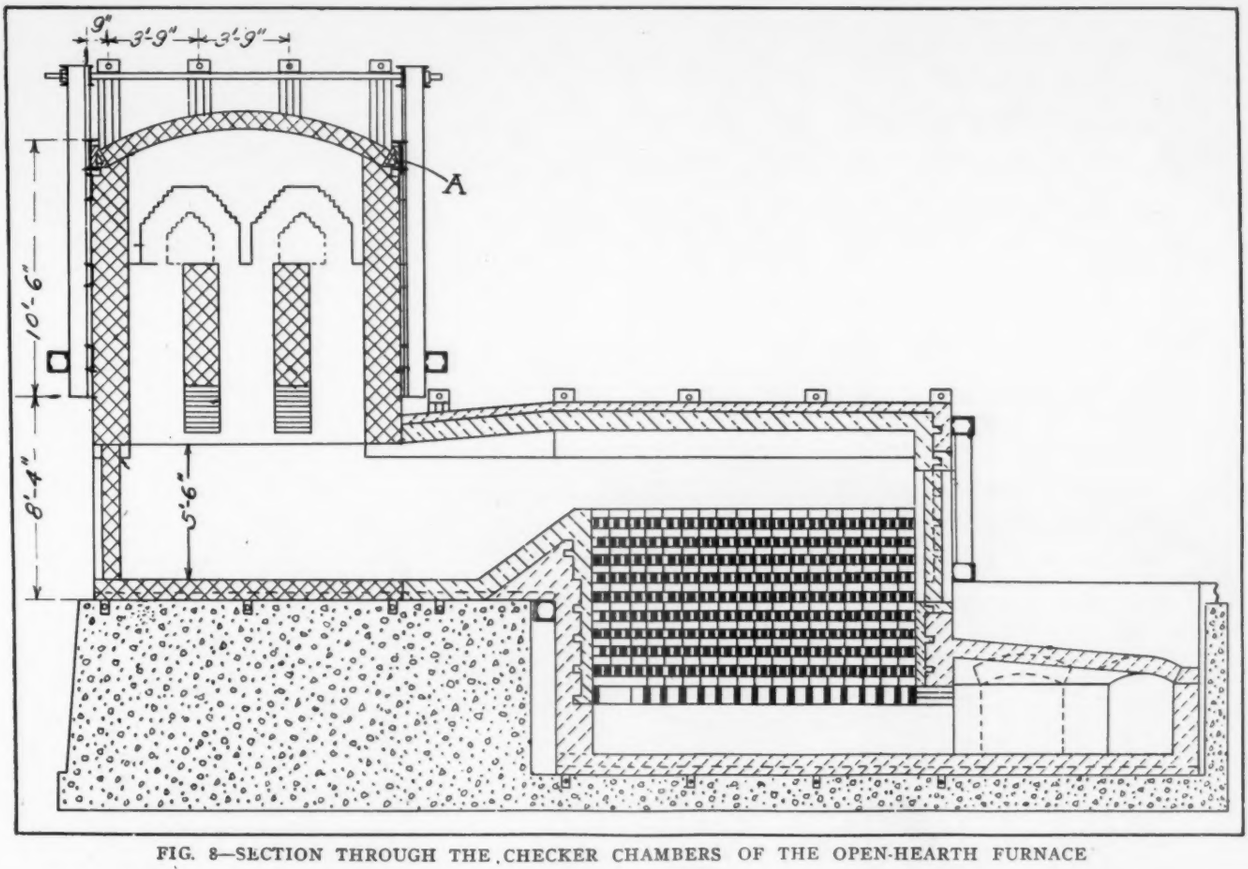


FIG. 8—SECTION THROUGH THE CHECKER CHAMBERS OF THE OPEN-HEARTH FURNACE

Air spaces, 2½ x 4½ inches, have been provided under the slag pockets.

The charging platform, Fig. 4, is of the customary steel plate construction supported on heavy I-beams. It is 34 feet in width and 17 feet, 8 inches in height above the top of the foundation slab. From the sill of the charging doors to the top of the platform, the distance is 2½ feet. In addition to the rails for the charging machine, a narrow gage track is laid on the platform back of the furnaces for the cars carrying the charging boxes.

The design of the furnace frame, which is extra heavy, is clearly indicated in Figs. 5, 7 and 8. The buckstays consist of heavy double I-beams held together at the top by a grill work of tie rods. There are 10 transverse and four longitudinal tie rods, the latter being placed over the former. The doors, door frames, sills and plates are cast steel. The hearth rests on 14-inch I-beams supported by concrete piers which are a part of the foundation monolith as indicated in Fig. 5. The hearth is 21 feet in length and 9 feet, 9 inches in width. The normal thickness of the bottom is 12 inches and the normal depth of the bath is 18 inches. The material is charged through three doors each 3 feet wide and 2 feet, 6 inches high. The doors are operated by hydraulic pistons and a wire rope gear. There are also two hand-operated doors on the front of the furnace for inspection purposes, one is 2 feet, 3 inches wide and the other 18 inches. Their location is clearly indicated in Fig. 5.

The ports have some interesting features. The gas ports are divided as shown in Fig. 7, each being 22½ inches wide and approximately 24 inches in extreme height. Their area, therefore, is approximately 878 square inches. The construction of the gas ports is such that there is a channel between them through which the air

is drawn, causing it to mix effectively with the gas. The channel also deflects the path of the flame downward, making it unnecessary to draw in the roof over the ports. The latter, therefore, is built straight across. The slag pockets under the gas ports are 3 feet wide, while those under the air ports are 3 feet, 9 inches in width.

The roof of the furnace is an arch of silica brick built to a radius of 11 feet, 3 inches and is 9 inches thick. The ends of the arch rest against triangular cast steel blocks which slide on a heavy channel, as shown at *A* in Fig. 7. This construction permits the roof and walls to expand freely without causing distortion or gas leaks.

The hearth, roof, ports and slag pockets are laid with the best quality silica brick. Unnecessary expense, however, has been avoided by lining the checker chambers with first quality clay brick instead of silica brick.

The details of the regenerators are shown in Fig. 8. Each chamber is 13 feet, 6 inches in length and 12 feet in height to the springing line of the arches. The air regenerators are 8 feet, 3 inches wide and the gas regenerators are 4 feet, 6 inches. An 18-inch clay brick wall separates the gas and air chambers.

The furnace is equipped with reversing valves of a special type designed to fit into the rather restricted space available. The gas valves are of the modified mushroom type with water seals at both ends of their stroke. They also are amply water-cooled. A hydraulic gear is used to reverse the valves.

The new annealing furnaces have not been erected although the designs are completed. They will be located east of the gas producer. The larger furnace will be 15 x 20 feet in inside dimensions and the smaller one, 10 x 12 feet. The general arrangement of both is shown in Fig. 9. They are of the car type with a movable bottom.

The platform constituting the bottom is carried on two four-wheel swinging standard gage trucks. This feature permits the bottom with its load of castings to be switched over the yard tracks to any point in the plant and it is thus expected that considerable rehandling will be avoided. When a heavy casting is to be annealed, the bottom will be brought into the molding room where the casting may be placed on it by one of the large traveling cranes. After being annealed, it can be switched into the machine shop or to any other point desired. The annealing furnaces are gas-fired. The ports are arranged to insure rapid and uniform heating. The doors, as indicated in Fig. 9, are counterbalanced and are electrically-operated. The outside dimensions of the larger furnace are 25 feet, 3 inches x 31 feet, 1½ inches, while those of the smaller furnaces are 20 feet, 3 inches x 21 feet, 10 inches.

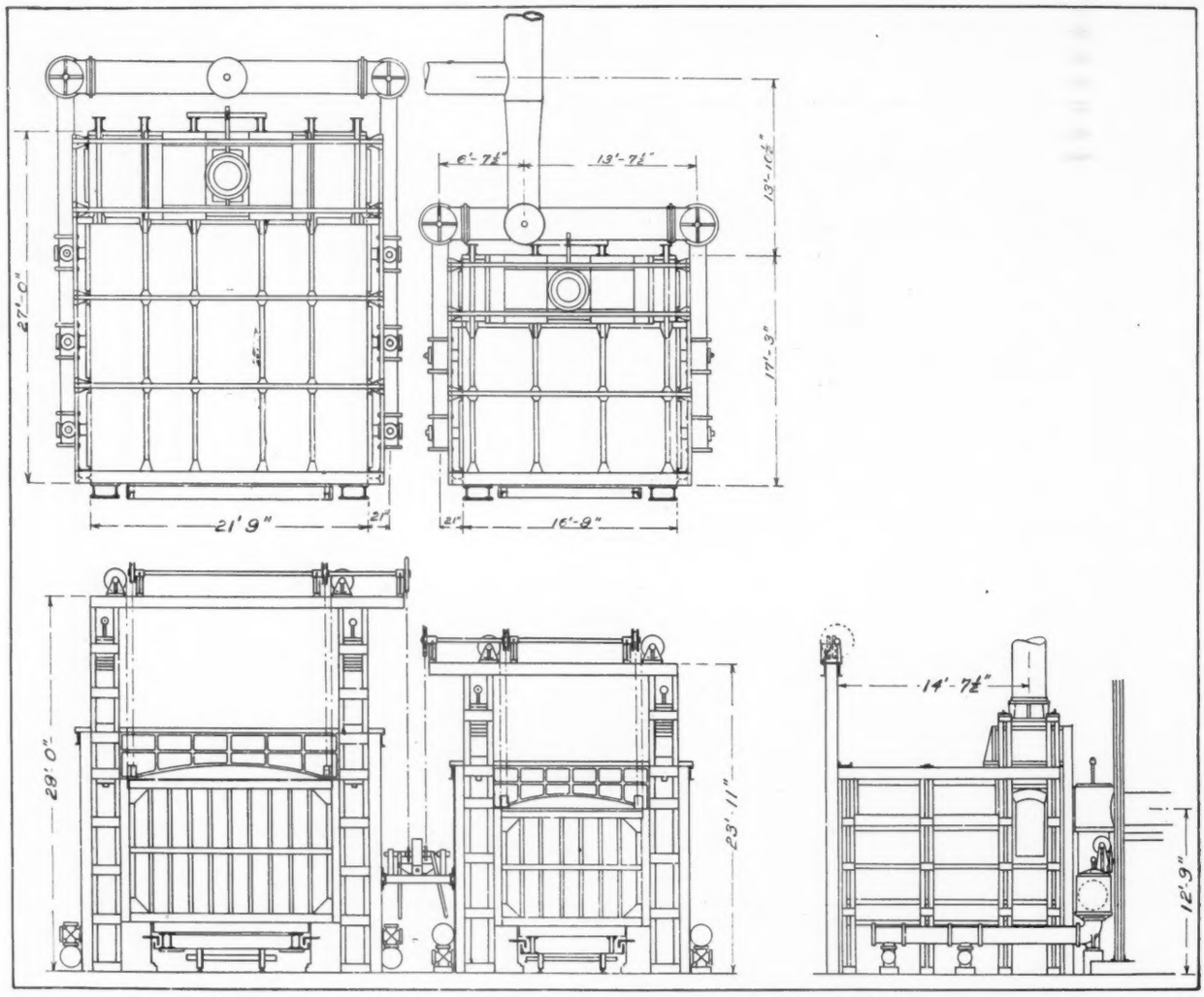


FIG. 9—GENERAL ARRANGEMENT OF THE ANNEALING FURNACES

Application of Chemistry in the Plating Room--V

Methods of Estimating Cyanide and Chlorine With Practical Examples for Figuring These Problems

By E P Later

OWING to the combinations which the alkali metal salts of hydrocyanic acid form with a number of metals, cyanide in the form of the potassium of sodium salt is extensively used in electroplating. In fact, it is practically impossible, in some cases, to secure satisfactory deposits without it. On the other hand, there are certain disadvantages connected with its use, which tend to make it of less value. Among these are its extremely poisonous nature and its great tendency to spot-out or *purge*.

Potassium cyanide is a white or grayish white substance, with a peculiar, not unpleasant odor, especially in small amounts. It generally is a mixture of both the sodium and potassium salts and may contain any amount of either, from a trace to nearly the full theoretical percentage. In other words, either sodium or potassium cyanide or a salt with varying amounts of both may be obtained.

Cyanides of Ordinary Metals

The cyanide of the ordinary, heavy metals are insoluble in water; the cyanides of the alkali metals, sodium and potassium, of the alkaline earths, barium, calcium and strontium and mercury in the mercuric state are soluble in greater or less degree.

Therefore, if we add potassium cyanide to a solution of a copper salt, we get a yellowish green precipitate of cupric cyanide. If an excess of cyanide is added, the precipitate dissolves completely, forming a double cyanide of copper and potassium or sodium, of the composition represented by the formula, 2 KCN . Cu $(CN)_2$. This compound is unstable and soon breaks up, forming cuprous cyanide. With many other metals, cyanide acts in a like manner, and since these double salts form excellent material for making plating solutions, they find extensive use.

In operating cyanide solutions, however, it is important to keep the content of this material within certain limits. Every plater knows that too much cyanide may prevent deposition altogether and causes trouble generally, while too little of it, allows the solution to become impoverished since the anodes are not attacked with sufficient vigor. It is not always easy to ascertain the amount present without making an analysis. For this purpose a standard solution of silver nitrate is required.

Dissolve 16.96 grams of pure silver nitrate in a small quantity of distilled water and then dilute to 1,000 c.c. This solution should be kept in a brown glass bottle, protected from the light.

Standardization

This solution is peculiarly liable to decomposition and consequent variation in strength. It should, therefore, be checked frequently and a standard solution of sodium chloride is the best to use for this purpose, since it is more easily obtained in a pure state and keeps its strength better than a solution of potassium cyanide.

A stock solution of sodium chloride should be prepared by weighing out exactly 5.850 grams of the pure, crystallized salt, dissolving in a small quantity of distilled water and diluting to 1,000 cubic centimeters.

Ten cubic centimeters of the solution are to be transferred to a beaker and 25 or 30 cubic centimeters of distilled water added, after which 3 or 4 drops of a solution of yellow potassium chromate are run in and the whole titrated with the silver solution until the last drop produces a permenent reddish tinge.

Calculation of Results

Since 10 cubic centimeters of the sodium chloride solution contains 0.0355 grams of cholrine and 10 cubic centimeters of the silver solution contains 0.107 grams of silver, exactly 10 cubic centimeters of the latter should be required for this test. In that case 1 cubic centimeter of the solution would be equivalent to 0.0130 grams of potassium cyanide.

If it is found, however, that the silver solution is not of this exact strength, its value in terms of potassium cyanide may be found in the following manner:

Determine the value of 1 cubic centimeter of the silver solution in terms of chlorine, by titrating with sodium chloride and dividing the number of grams of chlorine in the amount of the solution taken for the test by the number of cubic centimeters of silver solution required. The corresponding value in terms of potassium cyanide may then be figured by the proportion 0.00355 : 0.013 :: X : Y, where X equals the actual value of the silver solution in grams of cholrine and Y then equals the value of the silver solution in grams of potassium cyanide.

To determine the amount of cyanide in plating solutions, pipette 10 cubic centimeters of solution into a beaker, add 25 cubic centimeters of distilled water and 3 or 4 drops of a sodium chloride solution. then titrate with N. 10 silver nitrate, stirring thoroughly meanwhile. A brownish white precipitate will separate out, but will redissolve as long as free cyanide is present. Therefore, the appearance of a faint, but permanent cloudiness indicates the end of the reaction. A sheet of black paper placed under the beaker aids materially in determining the end point.

Calculation of Results

Since 1 cubic centimeter of strictly N/10 silver nitrate is equivalent to 0.013 grams of potassium cyanide, the number of cubic centimeters required multiplied by 0.173 expresses the result in ounces of free cyanide per gallon. If the silver solution is not of this exact strength, its value per cubic centimeter in terms of cyanide should be multiplied by the number of cubic centimeters required for 10 cubic centimeters of the plating solution. This result times 13.3 will express the cyanide content in ounces per gallon.

Cyanide solutions vary in their content of this according to the metal plated and the requirements and conditions to be met. Each plater must decide for himself, therefore, what is the proper amount for giving the best service, or a freshly made solution may be analyzed and the cyanide content determined. It may be kept at the desired point thereafter by making tests every day or so and adding the required amount of material.

All cyanide baths suffer a gradual decomposition. The carbonic acid in the air changes the potassium cyanide to potassium carbonate, setting hydrocyanic acid free, or under some cir-

cumstances, ammonia and potassium formate may result. The passage of the electric current also splits up the cyanide, hydrocyanic acid and hydrogen escaping as gases, with the potassium remaining behind as hydroxide and carbonate.

Instead of adding fresh potassium cyanide, it is possible to add barium cyanide to a solution which requires building up. The potassium carbonate and barium cyanide then react with each other and make an exchange, with the result that potassium cyanide and barium carbonate are formed. The latter salt is insoluble, however, and precipitates out as a white sludge.

The above procedure has one advantage which is worthy of mention and that is it does not load up a solution with a lot of useless, inert salts. In the course of time, through the constant addition of potassium cyanide, the content of potassium, in the form of the carbonate mostly, becomes high. By the use of barium cyanide, however, the potassium may all be converted into the cyanide, without increasing the concentration of the solution, since the barium is precipitated at once in the form of carbonate.

In bringing up the quantity of cyanide by the addition of fresh material, however, it must be borne in mind that the formate and other potassium salts tend to take the place of the cyanide in lowering the resistance of the bath, although they do not attack the anodes. If the calculated amount of cyanide is added, there is some danger of getting too much, thereby lowering the resistance unduly, so that useless care is taken, the deposit will tend to form too rapidly and be less adherent. No rule which will fit all cases can be given and experience and observation must be largely relied upon in the present instance.

From a consideration of some of the preceding statements, it is obvious that the strongest material obtainable should be used for increasing the cyanide content of a plating solution, since if a salt containing a relatively low percentage is used, a large amount of potassium compounds will be introduced unnecessarily.

Strength of Material Used

This naturally brings us to the question of knowing or determining the strength of the material purchased or used. It was noted at the beginning of this article that ordinary commercial cyanide may consist of the sodium or potassium salt alone or these two metals may be present in almost any proportions. The theoretical content of cyanogen in pure potassium cyanide is approximately 39 per cent; on account of the lower atomic weight of sodium, pure cyanide contains a little over 52 per cent cyanogen. There are a number of grades of this material on the market, containing varying amounts of cyanogen. Since this is the active radical and the part that does the work, it does not make much difference ordinarily whether it is hooked up with sodium or potassium, and the price of the material is governed by the cyanogen content. The so-called 98 per cent cyanide refers to a potassium compound containing a considerable amount of sodium and around 40 per cent of cyanogen; 130 per cent cyanide is the sodium salt calculated to potassium. In other words, 100 pounds of sodium cyanide contain as much cyanogen as 130 pounds of potassium cyanide. The determination of the strength of the material is essentially the same as that for testing plating solutions.

Determination of Cyanogen

To determine cyanogen in potassium or sodium cyanide, about 1 gram of salt is weighed out and dissolved in water in a 100 cubic centimeter volumetric flask, the solution then being diluted to the mark. Ten cubic centimeters are removed with a pipette and run into a beaker, 25 cubic centimeters of distilled water added and the whole titrated with standard silver nitrate as before. The addition of a drop or two of dilute sodium chloride solution will serve to make the end point more distinct.

It is evident that 0.1 gram of material was actually titrated, consequently if the number of cubic centimeters of silver nitrate solution required are multiplied by 10 and this by the value of each cubic centimeter in grams of potassium cyanide the result will be the weight of the latter in one gram of salt. Moving the decimal point two places to the right will express it as percentage.

As an example, suppose 1 gram of salt was dissolved and diluted to 100 cubic centimeters, 10 cubic centimeters being titrated. Assume that 7.5 cubic centimeters of standard silver nitrate were required. Then $7.5 \times 10 \times 0.0130 = 0.975$ grams, which is the actual amount of potassium cyanide in 1 gram of salt. Moving the decimal point two places to the right we get 97.5 per cent of potassium cyanide.

It should be remembered that this cyanide may be present as the sodium salt and not as potassium cyanide. More than likely, however, the cyanide of both of these metals will be present. For all practical purposes, however, it makes no difference which of these predominates, since they react the same.

Sometimes it may be better to express the result as free cyanogen, instead of the metallic salt. To do this it is only necessary to use the value of the silver solution in terms of cyanogen in place of potassium cyanide in making the calculations. Since 1 cubic centimeter of N/10 silver natrate is equivalent to 0.0130 gram, KCN, it corresponds to 0.0052 gram of cyanogen.

In the foregoing example, therefore, $7.5 \times 10 \times 0.0052 = 0.3900$ gram. Moving the decimal point two places to the right we get 39.0 per cent of cyanogen.

Sodium chloride, common table salt, is used extensively in plating, being added to the solutions to make them conduct better. It has no effect on the process, beyond a possible tendency to cause the anodes to dissolve more freely and readily which is occasioned by the chlorine set free at the positive pole from the decomposition of the salt into sodium and chlorine. This latter is an energetic element under ordinary conditions and when in the nascent state, that is, just set free from combinations, is much more so. It is often desirable to estimate the amount of salt present in a solution or to determine the chlorine in various things and since the procedure is similar to that given for cyanogen, it will be considered here.

A standard solution of silver nitrate is required, and the preparation and standardization of this has been given previously. To determine sodium chloride, NaCl, in plating or other solutions, 10 or 20 cubic centimeters are run into a beaker and cautiously neutralized with ammonia, and then 20 or 25 cubic centimeters of distilled water and 3 or 4 drops of a solution of potassium chromate, K_2CrO_4, are added as an indicator.. The solution must be cold before being titrated. The standard silver solution is now added from a burette until a drop of it produces a permanent reddish tinge. As long as any chlorine is present, the silver combines with it and is precipitated as a white, curdy compound, silver chloride, but when it has been all removed, the silver and potassium chromate react forming red silver chromate.

Chlorine Determination

One cubic centimeter of a strictly N/10 silver nitrate solution is equivalent to 0.00355 gram of chlorine, Cl, or 0.00564 gram of NaCl. Therefore, if 10 cubic centimeters were taken for analysis, multiplying the value of 1 cubic centimeter of silver solution by the number of cubic centimeters required, we get the number of grams of chlorine or sodium chloride present in that amount. Moving the decimal

point one place to the right expresses the result as per cent. If it is desired to express it as ounces per gallon, this may be done by multiplying the per cent by 1.33.

In the case of solutions which are difficult to neutralize, or when for any reason it is desirable to titrate an acid solution, a somewhat different procedure must be followed. In this, use is made of some of the peculiarities of the precipitated silver chloride, which enable it to subside readily on being shaken, and leave a clear solution, thus making the use of an indicator unnecessary.

Another Method

Ten or 20 cubic centimeters of the solution to be tested are run into a narrow mouth, glass-stoppered bottle, diluted to 50 cubic centimeters with chlorine-free, distilled water and a few drops of strong nitric acid added.

The bottle should be protected from sunlight during the titration. The best way of doing it is to slip it into a short cylinder or wrapper of brown or black paper, or it may be wrapped in a black cloth. Silver chloride decomposes and turns black very rapidly on exposure to light.

The standard silver solution is then added from a burette, a large proportion of the total quantity required being run in at once. The bottle is then stoppered and shaken briskly and the precipitate is allowed to settle. By tapping the side gently any floating or adhering particles can be made to sink. As soon as the solution has cleared, more of the silver solution is added and the bottle is again shaken. This is repeated until no further precipitation is caused by the silver.

As this point is approached, the precipitate settles less rapidly and the solution accordingly does not clarify so well, so that the end point may easily be overstepped, until some experience has been obtained.

When it is thought that the end point has been reached, the reading is taken. In order to ascertain if an excess of silver has been added, a few drops of the standard sodium chloride solution, which was previously used for standardizing may be added. Any turbidity or precipitate is evidence that more than enough silver solution was added. The excess may be determined by titrating as before with sodium chloride in place of silver nitrate, until no further precipitation takes place. The amount of chloride solution necessary is then subtracted from the number of cubic centimeters of silver solution which was added and the results calculated as before.

An example may make this clearer. Twenty cubic centimeters of solution were taken for a test, diluted to 50 cubic centimeters and a few drops of nitric acid added. A total of 1.43 cubic centimeters of silver nitrate were run in and on allowing the precipitate to settle and testing with a drop of N/10 sodium chloride, a perceptible turbidity was produced. The chloride solution was then run in from a burette a drop or two at a time, until no further cloudiness was produced. This required 0.45 cubic centimeters.

Example

Since the silver nitrate and sodium chloride solutions were both strictly N/10, it is apparent that 1 cubic centimeter of the one was equal to 1 cubic centimeter of the other; therefore, an excess of 0.43 cubic centimeters of silver solution had been added. Subtracting, $1.43 - 0.45 = 1.385$ cubic centimeters which was the quantity required to combine with the chlorine present.

Each cubic centimeter of nitrate solution is equivalent to 0.0035 grams of Cl.; $1.385 \times 0.0035 = 0.00485$ grams of Cl. in 20 cubic centimeters of the sample. If 100 cubic centimeters = 100g. then $5 \times 0.00485 = 0.02425$ grams or 0.024 per cent.

DIFFICULTIES OF THE PLATER

The Reason Why and the Remedy

Dense Nickel Deposit

Our nickel solution plates too dense, that is, we experience considerable difficulty in obtaining a good polish on the nickel when it is buffed. What should be added to the solution in order to soften the plate?

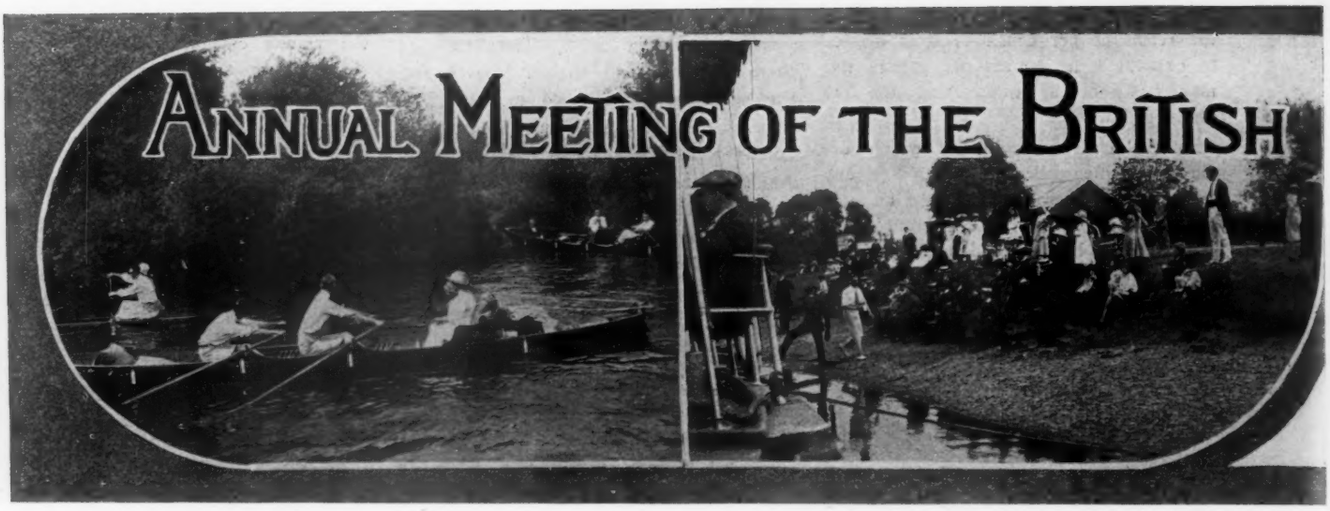
Undoubtedly the electric current passing through your solution is too strong or the voltage is too high, and you are, therefore, forcing the deposit. Deposits made in this way are difficult to color although obtained from a solution which is in perfect condition. If this is the case, reduce the tension or volume, as the case may be, and if necessary, increase the time for the deposition of nickel. The solution density for your class of work should not exceed 5½ Buaume, and if the density is greater than this, remove some of the solution and refill the tank with water. For each gallon of nickel solution use two ounces of boracic acid, which should be dissolved in a portion of the solution by boiling, and add it to the solution in the tank. If after reducing the voltage and density of the solution and adding the boracic acid the deposit is appreciably slower in forming, make a further addition of 10 ounces of sal-ammoniac dissolved in hot water to each 50 gallons of the nickel solution. It is advisable to strike the casting quickly when first placed in the bath and to allow a current of considerable volume to flow during the first few minutes and then to reduce the volume of current and to permit the finishing layers of nickel to form more slowly. The boracic acid will enable you to obtain a white, soft, tough deposit which will color easily if the proper current conditions are maintained.

Stripping Silver From Steel

I desire some information regarding the method of stripping silver from steel and also silver from German silver or brass articles which are to be refinished.

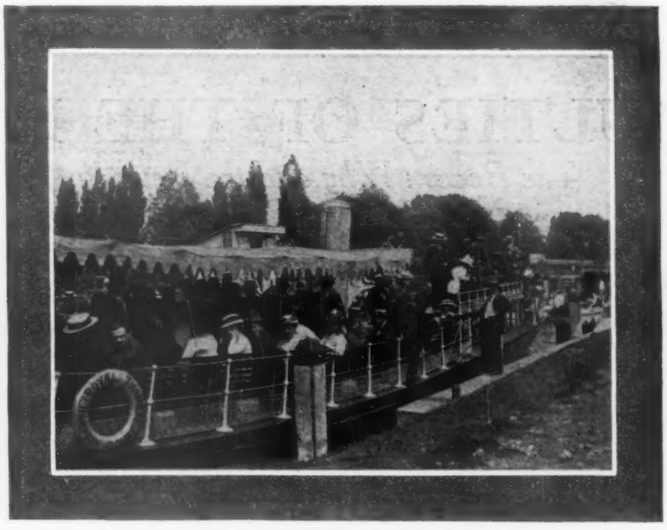
To remove silver from steel, use the article as an anode in a solution of chloride of silver, ½ ounce; potassium cyanide, C. P., 8 ounces, and water, 1 gallon, with a current tension of about 2 volts. A silver anode may be used as the cathode. In preparing the solution, make an emulsion of the silver chloride in a small portion of the cyanide and water and stir it into the remainder of the potassium cyanide solution. To remove silver from German silver or brass, use as a dip a solution of saltpeter, ½ pound, and oil of vitriol, 1 gallon. When plating German silver, use extra care in cleaning.

Annual Meeting of the British



ALONG THE RIVER THAMES WITH THE MEMBERS

THE British Foundrymen's Association signalized the completion of its first decade of existence by a number of interesting departures. This year's convention, the tenth of the series, was the first to be held in London. It also marked the abandonment of the August Bank holiday week as the time of meeting. Another innovation was the inauguration of an annual dinner which was held on the evening of Monday, June 23, the first business day of the convention. The general attendance, both in number and representative character, fully justified the new arrangements. Concurrent with this meeting was the first foundry trades exhibit held in Great Britain. This show had been opened the week previous in the Agricultural Hall, and the members in attendance at the annual meeting accepted the invitation of the directors of the exhibit to lunch and to view the displays on the Saturday preceding the convention. On Sunday an excursion on the Thames was arranged by the committee of the London branch. Going by train from Waterloo Station to Hampton Court the party, numbering over 100, embarked upon the specially-engaged steamer, the Royal Thames, and traveled up the winding river for many miles until Egam was reached.



LOCKING-THROUGH ON THE RIVER THAMES

Visits to Plants

The visits arranged for the following three days presented a charming and instructive variety. On Monday afternoon one party visited the works of the Great Eastern Railway at Stratford, near London, where tea was provided by the directors. The other visit was to the engineering and boiler works of Fraser & Chalmers at Erith-on-Thames.

The Royal Arsenal at Woolwich was visited on Tuesday afternoon and in the evening the foundrymen attended the Coliseum theater in a body. As there were no business sessions on Wednesday, a whole-day excursion was arranged to the works of the London & Southwestern railway.

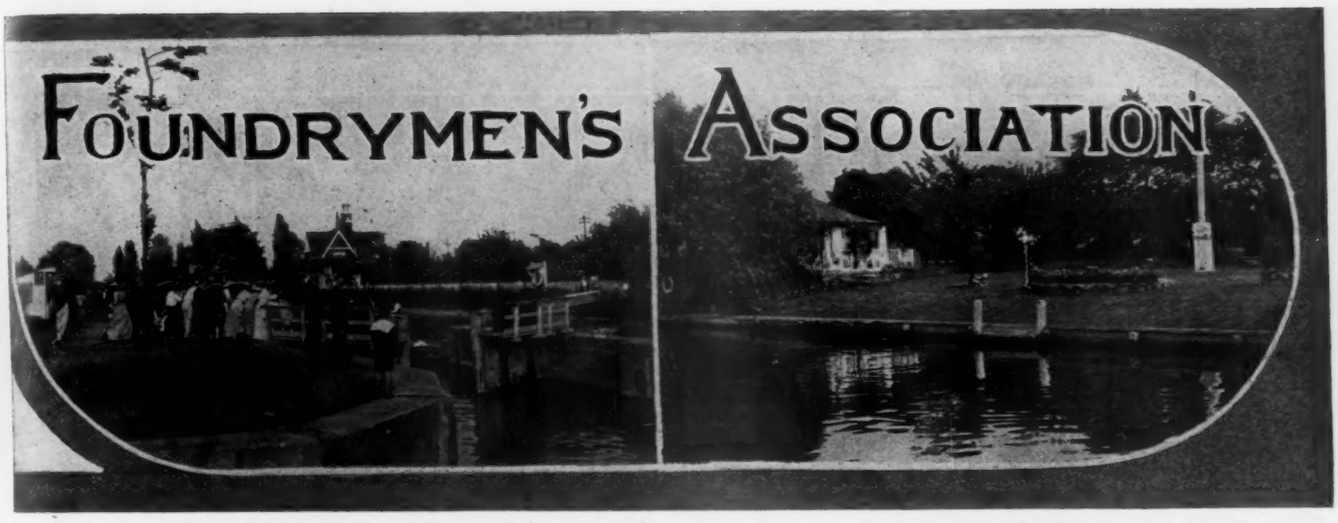
The professional sessions of the convention were held on the morning of Monday and Tuesday, June 23 and 24, in the Connaught rooms. The council presented a report dealing with the year's work. The membership of the association has reached a total of 923, and the enrollment of the various branches follows: Birmingham, 311; Halifax, 130; London, 109; Lancashire, 159; Newcastle-on-Tyne, 76; Sheffield, 104, and the Scottish branch, 155.

Election of Officers

The convention opened with Charles Jones, president of the British Foundrymen's Association, in the chair. He proposed the election of Senior Vice President Sydney A. Gimson, of Leicester, as his successor, and he was the unanimous choice. J. E. H. Allbut, who has been the secretary of the association for a number of years, tendered his resignation owing to the fact that his business affairs made it impossible to devote the necessary time to the duties of this office. E. A. Plinkington was elected successor to Mr. Allbut. W. Mayer, of Leavenbank Foundry, Dumbarton, Scotland, was elevated from the junior to the senior vice presidency, and J. Ellis was elected junior vice president. F. W. Finch was re-elected treasurer.

Members of the council were elected as follows: H. Pemberton, J. E. H. Allbut, M. Riddell, J. G. Robinson, T. Swinden, W. F. Bagnall, H. Jewson, J. B. Tattersall and H. Sherburn.

An illuminated address was presented to Percy Longmuir, Carnegie medallist, who served as president for two years before Mr. Jones was elected. The address, which was pre-



OF THE BRITISH FOUNDRYMEN'S ASSOCIATION

By J Horton, Staff Correspondent

sented by President Jones on behalf of the council, referred to Mr. Longmuir's distinguished position as a practical foundryman, scientist and author.

Presidential Address

Sydney A. Gimson, president-elect, in his address referred to the growth of the association from the time of the first meeting held in Manchester when 94 members were enrolled. In a period of 10 years the growth of the organization has been nearly tenfold, and there is every indication of further expansion both in influence and membership in the next few years. He discussed at length the importance of the foundry industry and referred briefly to the intricacies of this practice. In conclusion he said:

"Let us rejoice that we belong to an industry with multifold aspects calling for our utmost exertion of brain, skill and muscle. Let us remember that while man makes work, work makes the man, and the end and aim of all work is the happiness and the physical and mental fitness of men and women."

"Semi-Steel", by M. Riddell, was the first paper presented which dealt with this process of strengthening and improving gray iron. Numerous suggestions were made for melting semi-steel mixtures which may be summarized as follows:

Work the cupola hot.
Select the scrap according to its section and avoid massive pieces.
Take care to insure a thorough mixture of the metals.
The shrinkage and contraction of semi-steel castings are greater than that of gray iron, the amounts varying with the proportion of steel used.
Owing to the reduction of phosphorus, etc., the range of fluidity of semi-steel is shorter than that of gray iron and the metal settles quicker.

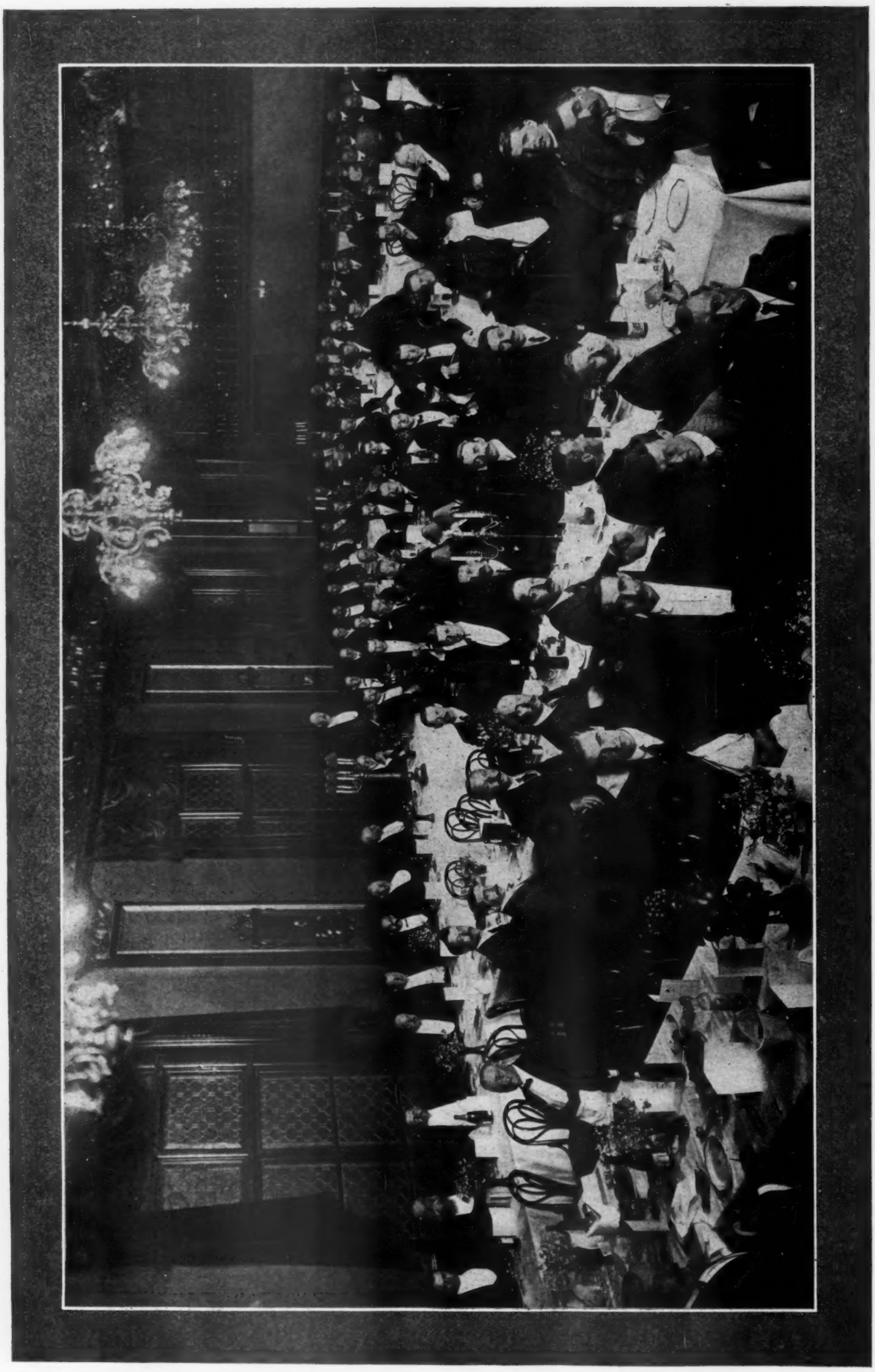
F. J. Cook, who opened the discussion, said that semi-steel was not required in England, although he admitted that the addition of steel to gray iron might improve its properties for certain purposes. With reference to the reduction of the total carbon by the use of steel, it was his experience that this was comparatively small.

R. Carrick said that semi-steel was in an embryo state in Great Britain. The author's theory with reference to the absorption of carbon appeared to him to be correct. This has been proved in carburizing for case-hardening where from 0.75 to 1 per cent of carbon frequently is absorbed. In making semi-steel mixtures Mr. Riddell said that he always used low carbon steel scrap. J. Smith stated that he had had a wide experience with semi-steel and found that he could get stronger iron by the use of steel in his mixtures than otherwise.

E. RONCERAY AND ANOTHER FRENCH DELEGRATE ARE IN THE CENTER OF THIS GROUP

E. Ronceray, of Ph Bonvillain & E. Ronceray, Paris, who represented the French Foundrymen's Association, directed attention to the fact that if steel is added to a gray iron mixture, it naturally will result in a reduction of the percentage of silicon. This will result in an increase in the combined carbon, thereby effecting a reduction in the graphitic carbon. He ventured the opinion that manganese neutralizes the action of sulphur, and it was his experience that not only is the iron improved by the addition of steel, but the cost of the product also is reduced.

In closing the discussion Mr. Riddell stated that steel strengthens weak iron and the results quoted in his paper prove his contention. He admitted that undoubtedly the silicon content of the mixture is reduced by the introduction of steel, but he did not believe that anything was gained by the addition of manganese to a semi-steel mixture except for the



ANNUAL DINNER OF THE BRITISH FOUNDRYMEN'S ASSOCIATION AT THE HOLBORN RESTAURANT, LONDON

purpose for which manganese is used in ordinary practice.

"Blast Quantity and Pressure in Cupola Working" was the subject of a paper presented by F. J. Cook. It was the author's opinion that both pressure and quantity of blast must be considered in the operation of a cupola and that the maximum output of metal per hour is more nearly comparative to the diameters of cupolas than to the areas of the furnaces. It was his opinion that the iron melted in a cupola is affected in hardness directly by the pressure of blast used, and that in consequence the total area of the tuyeres employed should be regulated according to the class of iron being melted, small areas being recommended when greater hardness is required. The height of a cupola from the top tuyeres to the charging door sill should not be less than 2½ to 3 times the diameter across the melting zone.

Written discussion of this paper from John Jermain Porter was presented in part as follows:

"It is a new idea to me that pressure is a factor affecting the rate of melting, aside from its influence on the quantity of air entering the cupola. Assuming a fixed ratio of fuel to iron, the rate of melting will depend upon the rate at which the fuel is burned. Assuming a fixed rate of blowing, the rate at which the fuel is burned will depend upon the way in which it is burned, that is, upon the proportion which is burned to carbon monoxide and the proportion burned to carbon dioxide. The most valuable and interesting of the conclusions contained in Mr. Cook's paper is the formula for the maximum possible rate of melting. On both sides of the water foundrymen have long realized that pressure is an important factor and that with too much pressure as well as with too great a volume of air, oxidation troubles and bad castings result."

In the ensuing discussion Mr. Gallon said that he regarded the formula given by the author as being of inestimable value from a scientific standpoint, but science, he said, could not always be applied in practice. For example, he wanted to know how he could obtain four or six tons of iron out of a cupola when he had a blower of only sufficient capacity to melt two tons an hour. Again, as a practical foundryman, he added that he did not have time to weigh the air when the blast was put on.

With reference to output, H. Pemberton directed attention to the fact that the quality of the coke used has a great influence on the melting capacity of the cupola. He asked for the author's views on the effect of the ratio between air and fuel on the strength of cast iron and he also wanted to know whether it would be necessary to change the area of the tuyeres and also their number during a day's run on miscellaneous work.

"The Artistic Treatment of Castings" was the subject of a paper presented by B. J. Fletcher, headmaster of the Leicester Municipal School of Art. This dealt with the artistic limitations which should govern the treatment of cast iron.

"The Alloying of Aluminum" was the subject of a paper presented by C. H. Ivinson, which is published elsewhere in this issue. The author was asked whether he could account for the fact that some aluminum alloys, when freshly made, showed physical deterioration and about two years later exhibited remarkable tensile and transverse strengths. Mr. Ivinson replied that the electrolytic action of aluminum alloys was a fascinating subject and he believed that electrolysis was the cause of this change. For example, he stated that an alloy of aluminum containing 5 per cent of tin when first cast would have a tensile strength of ten tons per square inch and in a few months this would be reduced to four tons per square inch. When titanium, up to a certain percentage, is alloyed with aluminum, titanic acid develops on the surface and the alloy rapidly corrodes.

MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION ABOUT TO START ON A TRIP ON THE THAMES

Considerable interest was manifested in the paper presented by E. Kilburn Scott entitled "Electric Furnaces in Iron and Brass Foundries." All of the various types of electric furnaces were briefly described.

"Standard Patterns for Motor Work" was the subject of a paper by J. W. Worrall and he precipitated an interesting discussion regarding the relation of the pattern-maker to the foundryman. Mr. Worrall said that it is his custom to quote three prices for patterns, namely, one for a model

for the experimental casting, another for a pattern to serve for 20 or 30 castings, and lastly a price for a standard pattern. "The Economics of Industry and Education" was the subject of a paper presented by Alexander Hayes.

Annual Dinner

The first annual dinner, held at the Holborn restaurant on Monday evening, was a symposium of good fellowship and good speeches and was enlivened by an excellent musical program. The first speaker was A. H. Hiorns, who proposed the health of the visitors, the list of which included Sir Hugh Bell, Prof. Huntington, president of the Institute of Metals, Dr. Rosenhain, head of the National Physical Laboratory, and E. Marshall Fox, a Sheffield steel manufacturer. The response for the visitors was made by Sir Hugh Bell. The toast of "Trade and Commerce" was responded to by Dr. Rosenhain, in the absence of Percy Longmuir. The toast of the evening, "The British Foundrymen's Association," was assigned to Prof. Huntington, and "American Progress in the Manufacture of Armor Plate" was discussed by Marshall Fox.

The first English Foundry Trades' exhibit was held in the Royal Agricultural Hall, London, from June 14

C. JONES,
Retiring president of the British Foundrymen's Association

to 28. Although there have been in London, exhibitions in which one branch or another of foundry practice has been presented, and highly successful foundry trades exhibitions have for some time been held annually in America, no attempt hitherto has been

SYDNEY A. GIMSON
President of the British Foundrymen's Association

made to hold an exhibition in Great Britain devoted entirely to the interests of foundrymen. This exhibit, although not large with regard to the number of individual displays, excited considerable interest and it is probable that it will be made an annual event. Various grades of foundry pig iron were shown by the Frodair Iron & Steel Co., and the molding machine exhibit of Ph. Bonvillain and E. Ronceray, Paris, France, was unusually extensive, a number of the machines having been shown in operation. The Peterson-National Co., Chicago, was the only American exhibitor and this concern displayed its extensive line of core oils, dry core compounds, etc. Numerous cores made with these oils and compounds from mixtures of American and English sands also were shown.

Following the inspection of the exhibits, the members of the British Foundrymen's Association were entertained at luncheon by the promoters of this enterprise. On behalf of the French Foundrymen's Association, E. Ronceray congratulated his English friends upon their first foundry exhibit and he hoped that it would be the forerunner of future shows of the same kind.

The world's supply of emery comes from the Greek islands and from Asia Minor near Smyrna. Importations into the United States average $250,000 annually, but shipments recently have been greatly interfered with owing to the disturbed conditions in the Balkans.

Electric Motor Clam Shell Bucket

A clam shell bucket operated by an electric motor built by the Hayward Co., New York City, is shown in the accompanying illustrations. The closing of this bucket is effected entirely by an electric motor, which, together with a drum, disc clutch and automatic stop, is fastened to the upper head of the bucket by two bolts. The motor, electric brake gearing, etc., are enclosed in a casing which is provided with hand holes at one end for easy access to the working parts of the motor. By removing the two bolts which hold the casing to the head of the bucket, it may be entirely detached, and disconnecting four other bolts, divides the shell or casing in two parts, thereby leaving the operating parts entirely exposed.

Current is supplied through a thick cable, the strain on which is taken entirely by a snap hook which prevents the possibility of breaking the circuit through excess strain on the cable. On the shaft which passes through the blade arms is located a sheave encased in a casting, the latter performing the double duty of protecting the sheave and serving as a counterweight to open the bucket. The closing is accomplished by a two-part wire rope line or chain, one end of which is fastened to the motor casing and passes

J. E. H. ALLBUT
Retiring secretary of the British Foundrymen's Association

over the sheave and back to the winding drum. The opening and closing of the bucket is performed entirely by the motor, which usually is controlled by the crane operator. As the closing and opening of the bucket is accomplished independently of the

operating mechanism it therefore is necessary to have only one hoisting drum.

As indicated in Fig. 1, the bucket with its opening and closing mechanism is attached to the crane hook and can be readily removed when the work for which the bucket has been called into service has been finished. The load may be dumped as gradually as desired without the shock of instantaneous discharge. The full load may be distributed over a number of different points, and this feature will prove of advantage in foundries when molding sand is being discharged into flasks too small to hold the entire contents of the bucket.

To prevent overloading the bucket, a disc clutch has been provided which is adjusted to slip before the danger point of overloading is reached. In the opening operation, when sufficient line has been wound to open the bucket to its full extent, an automatic stop prevents the opening and closing line from re-winding on the drum. This stop is positive in action, a latch being thrown into engagement by the opening and closing line when the bucket is opened to its maximum spread. The automatic cable take-up reel is made to carry up to 500 feet of cable and may be located in any convenient position. This bucket is made in capacities from three-quarters cubic yard upward, and can be operated either by a direct or alternating current motor. It may be used to advantage on all classes of derricks, cranes, etc., and can be used to advantage in industrial plants of all kinds to handle materials that a clam shell bucket will dig.

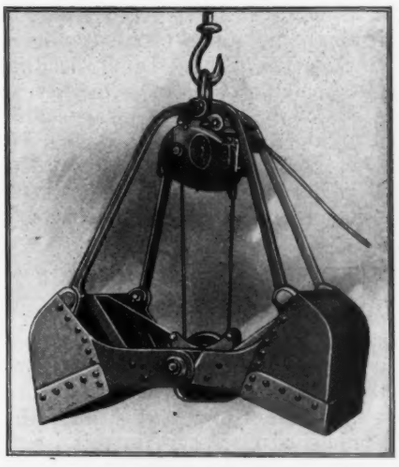


FIG. 1 — ELECTRICALLY - OPERATED CLAM SHELL BUCKET IN OPEN POSITION

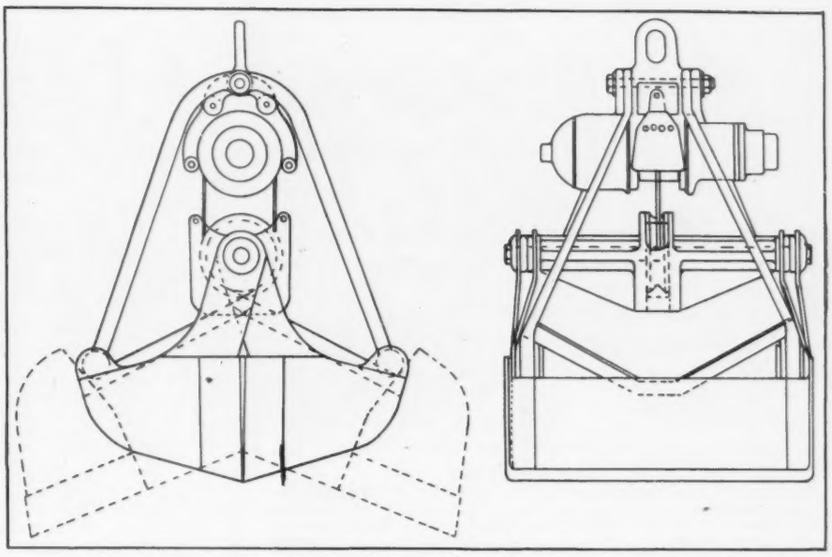


FIG. 2—END AND SIDE ELEVATION OF ELECTRICALLY-OPERATED CLAM SHELL BUCKET

According to statistics recently issued by Henry R. Merton & Co., London, the copper production of the world in 1912 aggregated 1,004,485 tons, of which the United States produced 554,835 tons. Mexico was the second largest producer, with 70,845 tons, and Japan ranks third with 65,500 tons.

Chicago Convention Preparations

THE local committee in charge of the foundry conventions which will be held in Chicago during the week of October 13, held its initial meeting at the La-Salle hotel July 15. The chairman of the various sub-committees announced informally the names of those who will serve with them. Subject to some slight modification, they are as follows:

Finance Committee: J. A. Galligan, Pickands, Brown & Co., chairman; David Evans, Chicago Steel Foundry Co., vice chairman; Joy Love, Aurora Foundry Co., Aurora, Ill.; A. H. Hayes, Johnston & Jennings Co.; M. A. Love, M. A. Love Mfg. Co., Rockford, Ill.; William Cribben, Cribben & Sexton Co.; E. J. Welch, E. J. Welch Foundry Co.; H. M. Wade, U. S. Wind Engine & Pump Co., Batavia, Ill.; George Pyott, Pyott Foundry Co., and D. M. Compton Jr., Quaker Mfg. Co.

Reception Committee: William Francis, Francis & Nygren Foundry Co., chairman; E. L. Cleveland, Garden City Foundry Co., vice chairman; C. M. Eddy, R. M. Eddy Foundry Co.; G. S. Burgis, Brady Foundry Co.; John O'Neill, Western Foundry Co.; W. B. Greenlee, Greenlee Foundry Co.; L. S. Rice, Allis-Chalmers Mfg. Co., and Thomas Jones, W. A. Jones Foundry Co.

Entertainment Committee: Charles B. Carter, American Brake Shoe & Foundry Co., chairman; E. F. Axner, Illinois Steel Co., vice chairman; Thomas Cummings, T. A. Cummings Foundry Co.; James Wood, Sheffield Foundry Co., and Frank Smith, Hewitt Mfg. Co.

Publicity Committee: O. J. Abell, *Iron Age*, chairman; A. O. Sonne, Rogers, Brown & Co.; H. L. Hanson, Chicago Steel Foundry Co., and A. G. Hawes, Matthew Addy & Co. All of the foregoing are in Chicago except where otherwise noted.

G. M. Spangler, manager of the convention bureau of the Chicago Association of Commerce, will act, *ex-officio*, as a member of the general committee.

The program for the meetings of the American Foundrymen's Association, the American Institute of Metals and the Associated Foundry Foremen are in process of preparation. Present indications are that an unusually valuable list of papers will be presented at the professional sessions, particularly relating to steel foundry practice and the casting of non-ferrous metals. The entertainment committee is planning some novel affairs.

Reservations for space already made in the International Amphitheatre, Halstead and Forty-second streets, where the Foundry & Machine Exhibition Co. will hold its eighth annual exhibition of foundry and shop equipment, insure an unusually complete and varied display.

THE FOUNDRY

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Trade Outlook

ALTHOUGH the production of castings was curtailed to some extent during the past month, many of the idle shops have resumed operations and the outlook for continued activity is bright. Recently, large contracts for castings for delivery the remainder of this year and during the first three months of 1914, have been placed by builders of automobiles and motor trucks, and in almost every instance, the requirements greatly exceed last season's demands. The tonnage placed with aluminum foundries was particularly heavy, notwithstanding the difficulties that have been experienced in obtaining these white metal castings thus far this year. A large amount of foreign aluminum is in bond, awaiting the action of Congress on the new tariff bill, and its release will greatly relieve many of the shops that have been unable to obtain a sufficient supply of raw material. Labor difficulties, to some extent, have interfered with operations in some centers and wages continue on an upward trend. Malleable and steel foundries report a continued heavy demand and shipments continue to be deferred from two to three months. The pig iron market shows some improvement with prices firm, while in some centers they have an upward tendency. Southern iron is firmer, and while it is still quoted on a basis of $10.50, Birmingham, some producers have advanced prices 25 to 50 cents a ton. In the leading producing centers, No. 2 foundry iron is quoted as follows: Pittsburgh, $14.55 to $14.90; Chicago, $15; Southern Ohio, Cincinnati, $14.50 to $15; Birmingham, $10.50 to $10.75; Philadelphia, $15.50 to $16, and Virginia iron, $13.50, furnace. Malleable Bessemer is held at $14.75, and Lake Superior charcoal, $16.25, Chicago.

Cupola Operations

A COMPREHENSIVE report of an investigation of cupola gases and temperatures conducted at the government testing laboratory at Pittsburgh, by the Bureau of Mines, the results of which are published elsewhere in this issue, confirms the findings of Dr. Richard Moldenke that the whole problem of obtaining hot iron is solved by using small charges evenly distributed on the fuel bed. This minimizes oxidation difficulties, and the experiments further show that the use of upper tuyeres not only is unnecessary, but is a positive detriment to the production of the best iron. The introduction of air into the fuel bed above the tuyeres, it is stated, even though in small volume, increases the liability of injurious effects from oxygen and serves no useful purpose. It is claimed that the increased tonnage supposed to be obtained by the use of upper tuyeres can be produced as easily by blowing through the bottom tuyere, the proper volume of air. This investigation is the first that has been undertaken to ascertain the reactions of the gases in a furnace during the iron melting operation and the results are of the greatest value not only to gray iron foundrymen, but to investigators who will pursue this subject further. One of the interesting results of this investigation is the measurement of the temperatures at various points in the cupola. The average temperature was found to vary from 2,766 to 2,845 degrees Fahr., although at one point in the cupola the temperature exceeded 3,000 degrees Fahr. The ideal melting region in the cupola also was located and defined.

Combined Jarring and Rock-Over Machine

A combined electrically-driven jar-ramming and rock-over drop molding machine has recently been placed on the market by Henry E. Pridmore, Chicago. The machine is built in various sizes, its capacity being limited only by the weight of flask which a man can conveniently rock-over by hand. The essential features of the Pridmore electrically-driven jar-ramming machine, described in THE FOUNDRY, June, 1911, and the special characteristics of the ordinary rock-over type have been carefully blended in the new design.

The pattern plate, which rolls over with the flask, is constructed of heavily ribbed cast iron, as indicated in Fig. 2, and is pivoted to the jolt table of the jarring machine. The motor is enclosed in a dust-proof sheet steel housing. The power is transmitted from the motor shaft to an enclosed worm and worm gear connected to a shaft on which a cam is fixed. The latter operates a bell crank lever, the cam contacting with a roller on one end of the bell crank. The table, which is well ribbed to uniformly distribute the blow, drops on a wood fiber ring on the base or anvil of the machine.

In operating the machine, the flask is first set on the pattern plate and filled with sand. The mold is then jolted to the required density, the surplus sand struck off and the bottom board clamped in place. The mold then appears as shown in Fig. 1.

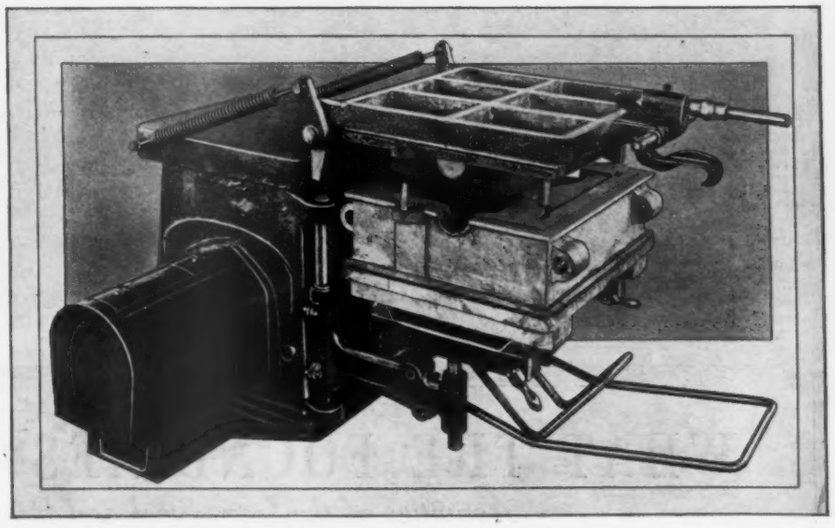

FIG. 2—FLASK ROCKED OVER AND DROPPED AWAY FROM THE PATTERN

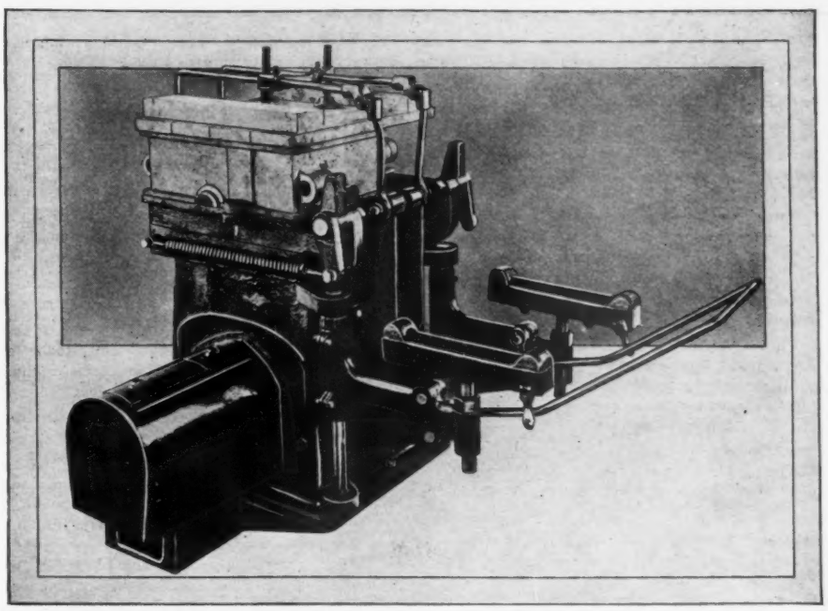

FIG. 1—JAR-RAMMING, ROCK-OVER MOLDING MACHINE WITH MOLD CLAMPED TO THE PATTERN PLATE

After being rolled over, in which operation the heavy spiral springs attached to the rock-over arms are of material assistance, the flask is dropped away from the pattern, as shown in Fig. 2. The pattern plate is then turned back to its normal position, Fig. 3, and the flask is removed from the machine.

The clamps holding the bottom board in place may be readily adjusted and quickly fastened. The flask rests are individually adjustable.

Personal

F. McCarthy, formerly associated with the Detroit Founders' Supply Co., Detroit, is now one of the sales representatives of the Hill-Griffith Co., Cincinnati.

Frank Powers has been appointed foreman of the polishing, buffing and nickel-plating department of the Sar-

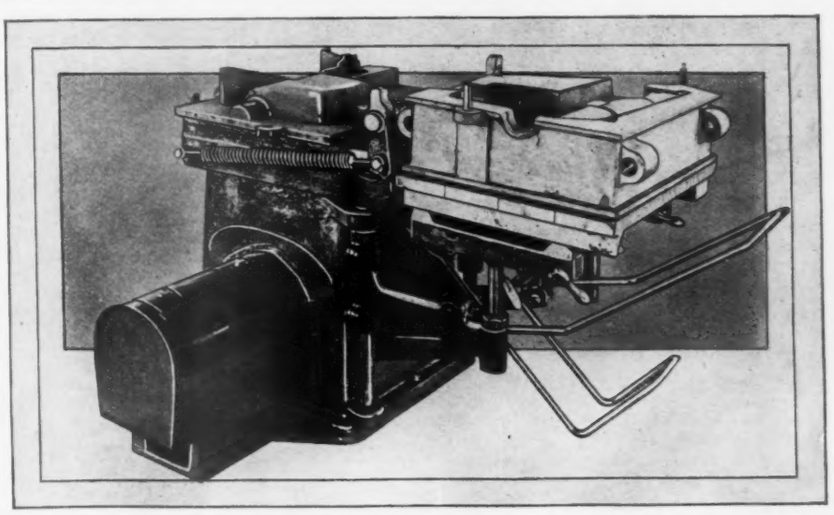

FIG. 3—MOLD FINISHED, WITH PATTERN PLATE IN NORMAL POSITI

nia, Ont., plant of the H. Mueller Mfg. Co., Decatur, Ill.

Samuel T. Greaves, formerly with the Vanadium Metals Co., Groton, Conn., has resigned to accept the position of superintendent of the foundry operated by the Vanadium Metals Co., Pittsburgh.

M. Z. Fox, formerly manager of the Detroit Foundry Supply Co., Detroit, is now associated with the Hill-Brunner Foundry Supply Co., Cincinnati. Mr. Fox will represent the Hill-Brunner company in the western part of Ohio and in the states of Michigan and Indiana.

T. K. Webster, president and one of the principal stockholders of the Webster Mfg. Co., Tiffin, O., has severed his connection with that concern. He has been succeeded by F. S. Shaw.

John A. Logan, formerly foreman of the brass foundry operated by the National Cash Register Co., Dayton, O., is now in charge of the foundry operated by the Delco Engineering Co., of that city.

John Cotter, who has had charge of the foundry operated by the Harland & Wolff Ship Building Works, Belfast, Ireland, for 32 years, recently resigned. At a reception tendered him he was presented with a purse of gold. During his connection with Harland & Wolff, Mr. Cotter developed the foundry from a shop employing six men to a plant engaging over 800 men at the present time.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Robert Mitchell Co., Montreal, is erecting a new foundry.

The Bradley Works, Kankakee, Ill., contemplates the erection of a foundry.

The Union Foundry Co., Fitchburg, Mass., recently has completed extensive improvements.

The foundry of the Chehalis Foundry & Machine Co., Chehalis, Wash., has been rented by William Lloyd.

The McHatton Foundry, Philadelphia, recently purchased the smelting plant formerly operated by John Wagner.

R. M. Franey, receiver for the Davis-Price Foundry & Machine Co., Wheeling, W. Va., has purchased the plant for $22,000.

The foundry operated by William Smith, at Beaverton, Ont., has been purchased by J. M. and J. O. Reid.

The Mains Foundry Co., Jacksonville, Fla., has been incorporated with $15,000 capital to engage in the manufacture of castings.

The plant of the Hartford Foundry Co., Hartford, Conn., which has been closed since June, will probably be sold at a receiver's sale in the near future.

The King Foundry Co., St. Joseph, Mo., has increased its capital from $25,000 to $40,000, to provide funds for extensive improvements to its plant.

The Shelby Foundry Co., Shelbyville, Fla., has been incorporated with $10,000 capital by H. Jones, A. H. Schnaitter and R. D. Thornbury.

The new plant of the Gadsden Pipe & Foundry Co., Gadsden, Ala., equipped to manufacture cast iron soil pipe, has been placed in operation.

The new addition to the plant of the Hamilton Foundry & Machine Co., Hamilton, O., is nearing completion. The building is 60 x 455 feet, of brick and concrete construction.

The new cast iron pipe foundry that is being erected at Birmingham, Ala., by the National Pipe & Foundry Co., will be placed in operation about the middle of September.

The Johnston Harvester Co., Batavia, N. Y., is installing a battery of four units of reel type core ovens in its new gray iron foundry. The ovens were built by the Quigley Furnace & Foundry Co., Springfield, Mass.

The Alloy Steel Casting Co., located near Wheeling, W. Va., has been succeeded by the Wheeling Steel Casting Co. An open-hearth furnace is being installed and the plant will be placed in operation in full about Sept. 1.

The Wisconsin Foundry Co., Racine, Wis., has built a gray iron shop, 60 x 80 feet, equipped to manufacture gas engine cylinder castings. A pattern shop also has been built, 30 x 40 feet.

The Novelty & Foundry Co., Macon, Ga., has been incorporated with $25,000 capital. The officers of the company follow: A. B. Miller, president; M. B. Leist, vice president, and W. D. Coulter, secretary and treasurer.

The American Iron & Brass Foundry, Incorporated, Los Angeles, Cal., has been organized with a capital of $20,000 and has leased the brass foundry at 688 Rio street for a period of two years. The officers of the company follow: C. S. Smith, president; H. H. Jones, secretary; A. H. Moore, treasurer, and W. T. Rabun, general manager.

J. Beckett and Charles Beckett, formerly affiliated with the Machinists' Foundry Co., Muncie, Ind., have organized the Delaware Brass & Aluminum Co., and have built a plant 60 x 80 feet, which will be devoted to the manufacture of brass and aluminum castings.

The Massey-Harris Co., Ltd., Toronto, Ont., has purchased additional land at Brampton, Ont., for the erection of a gasoline engine plant. However, the report that the company's foundry will be removed from Toronto has been denied and building operations at Brampton will not be undertaken for at least twelve months.

The Best Foundry Co., Bedford, O., is erecting an addition to its plant, 200 feet long, and 4,800 feet of mono-rail is being installed to command all of the floors of the shop. The mono-rail will be equipped with 75 electrically-operated trolleys. The assembling department also has been enlarged and now covers 144,000 square feet. Another cupola also has been added, the metal now being melted in four furnaces.

The Rutenber Motor Co., Longansport, Ind., is preparing to increase its output and is planning to manufacture stationary and automobile engine castings for the trade. This company now manufactures castings for the Reutenber Motor Co., Marion, Ind., which has taken about 60 per cent of its output in the past. The installation of a large amount of new equipment has materially increased the producing capacity.

New Construction

The Anthes Foundry Co., Ltd., Winnipeg, Canada, will build an addition to its plant.

The Ajax Co., Corry, Pa., is preparing plans for the erection of a new foundry.

The Clarke-Banks Foundry Co., Buffalo, is building an iron foundry, 40 x 60 feet.

The Cincinnati Foundry Co., Cincinnati, is erecting a new plant for the manufacture of gray iron castings.

The General Railway Signal Co., Rochester, N. Y., is building an addition to its foundry which will double the present capacity.

The Otis Fenson Elevator Co., Hamilton, Ont., is having plans prepared by Stewart & Wilton, architects, for a new foundry.

The General Electric Co., Schenectady, N. Y., will add a new plating department to its plant at Lynn, Mass. The main building will be 60 x 180 feet.

The J. H. Kelly Machine Works, Mt. Gilead, O., is building an iron foundry, which will be placed in operation early in the fall.

The Buckwalter Stove Co., Royersford, Pa., contemplates the installation of a sand blast cleaning plant, and considerable polishing equipment also will be added.

The Novo Engine Co., Lansing, Mich., will erect a pattern shop and pattern storage building. H. E. Smith, consulting engineer, 103 Capitol National Bank building, Lansing, has prepared the plans and specifications.

The new foundry built by the J. D. Klein Foundry & Wire Co., Oklahoma City, Okla., has been placed in operation. The plant consists of two buildings, one 65 x 135 feet and the other 50 x 140 feet.

The Allyne-Ryan Foundry Co., Cleveland, will erect a new addition to its plant, 112 x 120 feet, which will be devoted to the production of cores. When completed the present core department, located at one end of the company's foundry, will be removed to the new building.

The Klumb Engine & Machine Co., Sheboygan, Wis., organized by Paul Klumb, for many years secretary of the Globe Iron Foundry, is erecting a new plant consisting of three buildings as follows: Main shop, 100 feet square; pattern shop, 18 x 36 feet, and power house, 30 x 40 feet.